



NCDMF Completion Report for Incidental Take Permit 1348

Sea Turtle Bycatch Monitoring of the 2001 Fall Gillnet Fisheries in Southeastern Pamlico Sound, North Carolina

Jeff Gearhart

April 2002

North Carolina Department of Environment and Natural Resources
North Carolina Division of Marine Fisheries
Fisheries Management Section
3441 Arendell Street
Morehead City, NC 28557

TABLE OF CONTENTS

TABLE OF CONTENTS.....	II
LIST OF TABLES	III
LIST OF FIGURES	V
INTRODUCTION	8
FISHERIES DESCRIPTION	9
Deep Water Large Mesh Gillnet Fishery	10
Shallow Water Large Mesh Gillnet Fishery.....	11
Shallow Water Small Mesh Gillnet Fishery.....	12
METHODS	12
ITP CONSERVATION PLAN.....	13
Permit Reporting	13
Sea Sampling.....	14
Management Measures.....	15
GEAR TESTING	17
RESULTS	18
PERMIT REPORTING	18
Fishing Activity.....	19
SEA SAMPLING	23
Gear Parameters	23
Finfish and Sea Bird Bycatch.....	28
Sea Turtle Bycatch	28
Sea Turtle Bycatch Estimates.....	31
GEAR TESTING	35
DISCUSSION.....	41
CONCLUSIONS AND RECOMMENDATIONS	43
LITERATURE CITED	44

LIST OF TABLES

Table 1. Number of sea turtle strandings by species from September 15 through December 15, 1999 in southeastern Pamlico Sound, North Carolina and maximum allowed strandings, estimated lethal takes, and estimated live takes for the same time period and area during the 2000 fishing season.....	15
Table 2. Maximum allowed estimated lethal takes and live takes by species from September 15 through December 15 for the PSGNRA during the 2001 fishing season.....	16
Table 3. Sea turtle entanglement rates for three tie-down gillnet configurations.....	17
Table 4. Net characteristics of three types of net evaluated in southeastern Pamlico Sound during the 2001 flounder gillnet season from October 19-December 4.....	18
Table 5. Summary statistics for gear parameters observed in the large and small mesh set gillnet fisheries and small mesh runaround gillnet fishery during the 2001 season.....	27
Table 6. Tabulation, by species, of relative biomass (weight kgs) and number of individuals observed aboard large mesh flounder gillnet vessels for 130 trips in southeastern Pamlico Sound during the 2001 season. All species are ranked by relative biomass (% weight).	29
Table 7. Tabulation, by species, of relative biomass (weight kgs) and number of individuals observed aboard small mesh set gillnet vessels for 52 trips in southeastern Pamlico Sound during the 2001 season. All species are ranked by relative biomass (% weight).....	30
Table 8. Tabulation, by species, of relative biomass (weight kgs) and number of individuals observed aboard small mesh runaround gillnet vessels for 7 trips in southeastern Pamlico Sound during the 2001 season. All species are ranked by relative biomass (% weight).	30
Table 9. Sea turtle takes observed in the large mesh flounder gillnet fishery in Southeastern Pamlico Sound during the 2001 fishing season. Carapace lengths are curved notch to notch measurements.	31
Table 10. Observed large mesh gillnet green sea turtle interactions, fishing effort (yards x soak days), flounder landings (lbs), and sea turtle bycatch rates based on fishing effort and flounder landings for each week and area where interactions were observed for the 2001 fishing season.....	35
Table 11. Reported large mesh gillnet fishing effort (yards x soak days), flounder landings, and green sea turtle bycatch estimates based on gear effort and landings for the 2001 fishing season. Estimates were calculated with bycatch rates listed in Table 10.....	35
Table 12. Estimated and allowed thresholds for lethal and live takes by species from September 15 through December 15, 2001 in the PSGNRA.	35

Table 13. Tabulation, by species, of relative biomass (weight kgs) and number of individuals collected by a standard flounder gillnet with tie-downs for 30 trips in southeastern Pamlico Sound during the 2001 season. All species are ranked by relative biomass (% weight).	37
Table 14. Tabulation, by species, of relative biomass (weight kgs) and number of individuals collected by a modified low profile flounder gillnet without tie-downs for 30 trips in southeastern Pamlico Sound during the 2001 season. All species are ranked by relative biomass (% weight).	38
Table 15. Tabulation, by species, of relative biomass (weight kgs) and number of individuals collected by a modified double leadline flounder gillnet for 30 trips in southeastern Pamlico Sound during the 2001 season. All species are ranked by relative biomass (% weight).	39
Table 16. Sea turtle interactions observed by net type during 2001 gear testing in southeastern Pamlico Sound.	40

LIST OF FIGURES

Figure 1. Map of southeastern Pamlico Sound and the 2000 Pamlico Sound Gill Net Restricted Area (PSGNRA).	9
Figure 2. North Carolina estuarine flounder gillnet fishing grounds in southeastern Pamlico Sound.	10
Figure 3. Diagram of a sink gillnet. The sink gillnet is submerged below the water line and consists of several net panels attached together as a string. This gear can be modified with tie-downs to target bottom-dwelling fish.....	11
Figure 4. NCDMF 2001 Pamlico Sound Gillnet Restricted Area (PSGNRA) and NMFS closed area. S1=Shallow Water Gillnet Restricted Area 1; S2=Shallow Water Gillnet Restricted Area 2; S3=Shallow Water Gillnet Restricted Area 3; OC=Ocracoke Inlet Corridor; HC=Hatteras Inlet Corridor.	14
Figure 5. Percent late and failed PSGNRA permit reporting by week for the 2001 fishing season.....	19
Figure 6. Number of valid and active PSGNRA gillnet permits by week for the 2001 fishing season.....	20
Figure 7. Number of active large and small mesh gillnet permits by week for the 2001 fishing season.....	20
Figure 8. Number of PSGNRA permittees reporting large mesh fishing activity by area and week for the 2001 fishing season.	21
Figure 9. Number of PSGNRA large mesh gillnet trips reported by area and week for the 2001 fishing season.	21
Figure 10. Flounder landings reported by PSGNRA large mesh gillnet fishermen by week and area for the 2001 fishing season.	21
Figure 11. Number of PSGNRA permittees reporting small mesh fishing activity by area and week for the 2001 fishing season.	22
Figure 12. Number of PSGNRA small mesh gillnet trips reported by area and week for the 2001 fishing season.....	22
Figure 13. Total landings reported by PSGNRA small mesh gillnet fishermen by week and area for the 2001 fishing season.	22
Figure 14. Large mesh trips observed (131), total trips reported (1,456), and observer coverage by week for the 2001 fishing season.....	24
Figure 15. Large mesh effort observed (148,784 yards/soak day), total fishing effort reported (1,867,329 yards/soak day) and observer coverage by week for the 2001 fishing season.....	24

Figure 16. Large mesh pounds of flounder observed (8,135 lbs), total pounds of flounder reported (116,990 lbs), and observer coverage by week for the 2001 fishing season.....	24
Figure 17. Small mesh trips observed (59), total trips reported (378), and observer coverage by week for the 2001 fishing season.....	25
Figure 18. Small mesh effort observed (54,148 yards/soak day), total fishing effort reported (301,950 yards/soak day) and observer coverage by week for the 2001 fishing season.....	25
Figure 19. Small mesh pounds of total catch observed (6,087 lbs), pounds of total catch reported (69,231 lbs), and observer coverage by week for the 2001 fishing season.....	25
Figure 20. Large mesh observed and reported mean CPUEs (lbs of flounder\1000 yards\day) and mean gear effort (yards x soak days) by week for the 2001 fishing season. Error bars represent standard deviations of the weekly means.....	26
Figure 21. Small mesh observed and reported mean CPUEs (total lbs\1000 yards\day) and mean gear effort (yards x soak days) by week for the 2001 fishing season. Error bars represent standard deviations of the weekly means.....	26
Figure 22. Coeffecients of variation (CVs) for observed large mesh fishing effort (lbs of flounder and gillnet yards x soak days) and observed small mesh fishing effort (total lbs and gillnet yards x soak days).....	27
Figure 23. Observed sea turtle interactions and large mesh gillnet sets in southeastern Pamlico Sound gillnet restricted areas from September 15-October 15, 2001.....	32
Figure 24. Observed sea turtle interactions and small mesh gillnet sets in southeastern Pamlico Sound gillnet restricted areas from September 15-October 15, 2001.....	32
Figure 25. Observed sea turtle interactions and large mesh gillnet sets in southeastern Pamlico Sound gillnet restricted areas from October 16-November 15, 2001.....	33
Figure 26. Observed sea turtle interactions and small mesh gillnet sets in southeastern Pamlico Sound gillnet restricted areas from October 16-November 15, 2001.....	33
Figure 27. Observed sea turtle interactions and large mesh gillnet sets in southeastern Pamlico Sound gillnet restricted areas from November 16-December 15, 2001.....	34
Figure 28. Observed sea turtle interactions and small mesh gillnet sets in southeastern Pamlico Sound gillnet restricted areas from November 16-December 15, 2001.....	34

Figure 29. Flounder catch for a standard deep water flounder gillnet with tie-downs (control), a double leadline gillnet and a low profile gillnet without tie-downs. Nets with the same letter are not significantly different from each other ($P<0.01$).	36
Figure 30. Bycatch for a standard deep water flounder gillnet with tie-downs (control), a double leadline, gillnet and a low profile gillnet without tie-downs. Nets with the same letter are not significantly different from each other ($P<0.0001$).	36
Figure 31. Bycatch components for a standard deep water flounder gillnet with tie-downs (control), a double leadline gillnet and a low profile gillnet without tie-downs.....	40
Figure 32. Locations of experimental flounder gillnet sets and sea turtle interactions in southeastern Pamlico Sound during 2001 gear testing.	41

INTRODUCTION

In November 1999, the North Carolina sea turtle stranding network noted significant increases in strandings in the southeastern portion of Pamlico Sound (Sea Turtle Stranding Report Zone 35, Inshore). During November and December, a total of 97 strandings occurred in this area. Following early stranding reports, National Marine Fisheries Service (NMFS) and North Carolina Division of Marine Fisheries (NCDMF) Marine Patrol conducted aerial surveys of eastern Pamlico Sound along Ocracoke and Hatteras islands to investigate fishing activities adjacent to the strandings. Marine Patrol checked gillnet sets and interviewed fishermen about set locations, gear parameters, and fishing practices. NCDMF Fisheries Management staff also investigated active fisheries by interviewing various fisheries participants collecting information on fishing practices, seasons, gear parameters, and frequency of sea turtle interactions.

Three active fisheries were identified: the shrimp trawl fishery; large mesh (> 5 inch stretched mesh) flounder gillnet fishery; and small mesh (< 5 inch stretched mesh) spotted seatrout (*Cynoscion nebulosus*) gillnet fishery. Shrimp fishing activities in the area were heavy and NCDMF Marine Patrol boarded several trawlers, all of which were equipped with functioning Turtle Excluder Devices (TEDs). Concurrently, NCDMF Fisheries Management staff conducted at-sea monitoring aboard gillnet vessels in southeastern Pamlico Sound during November 22-24, 1999. Eleven observer trips were conducted, consisting of five trips aboard flounder gillnet vessels and six trips aboard spotted seatrout gillnet vessels. Two sea turtle takes were observed in the flounder fishery while no takes were observed in the spotted seatrout fishery. Considering this information, NMFS issued an emergency rule on December 10, 1999 closing southeastern Pamlico Sound to gillnets larger than 5 inch stretched mesh to protect endangered and threatened sea turtles (64 FR 70,196, December 16, 1999). The closure remained in effect through January 9, 2000.

During the next six months, NCDMF, in consultation with NMFS, prepared an application for an Incidental Take Permit (ITP) under Section 10 of the Endangered Species Act (ESA) (65 FR 47,715, August 3, 2000). The ITP authorized implementation of management measures during the fall of 2000 to protect threatened and endangered sea turtles while allowing gillnet fisheries for flounder to be prosecuted within designated areas of Pamlico Sound. On October 5, 2000, NMFS issued ITP #1259 to NCDMF (65 FR 65,840, November 2, 2000). A key component of the permit was a comprehensive conservation plan. The primary goal of this plan was to reduce sea turtle strandings in southeastern Pamlico Sound by 50% from September 15 through December 15, 2000 relative to 1999 strandings during the same period. To achieve this goal, NCDMF designated the Pamlico Sound Gill Net Restricted Area (PSGNRA, Figure 1). Strict management measures were imposed and a comprehensive fishery monitoring program was implemented that required fishing permits, weekly reporting, and mandatory observer coverage (Gearhart 2001).

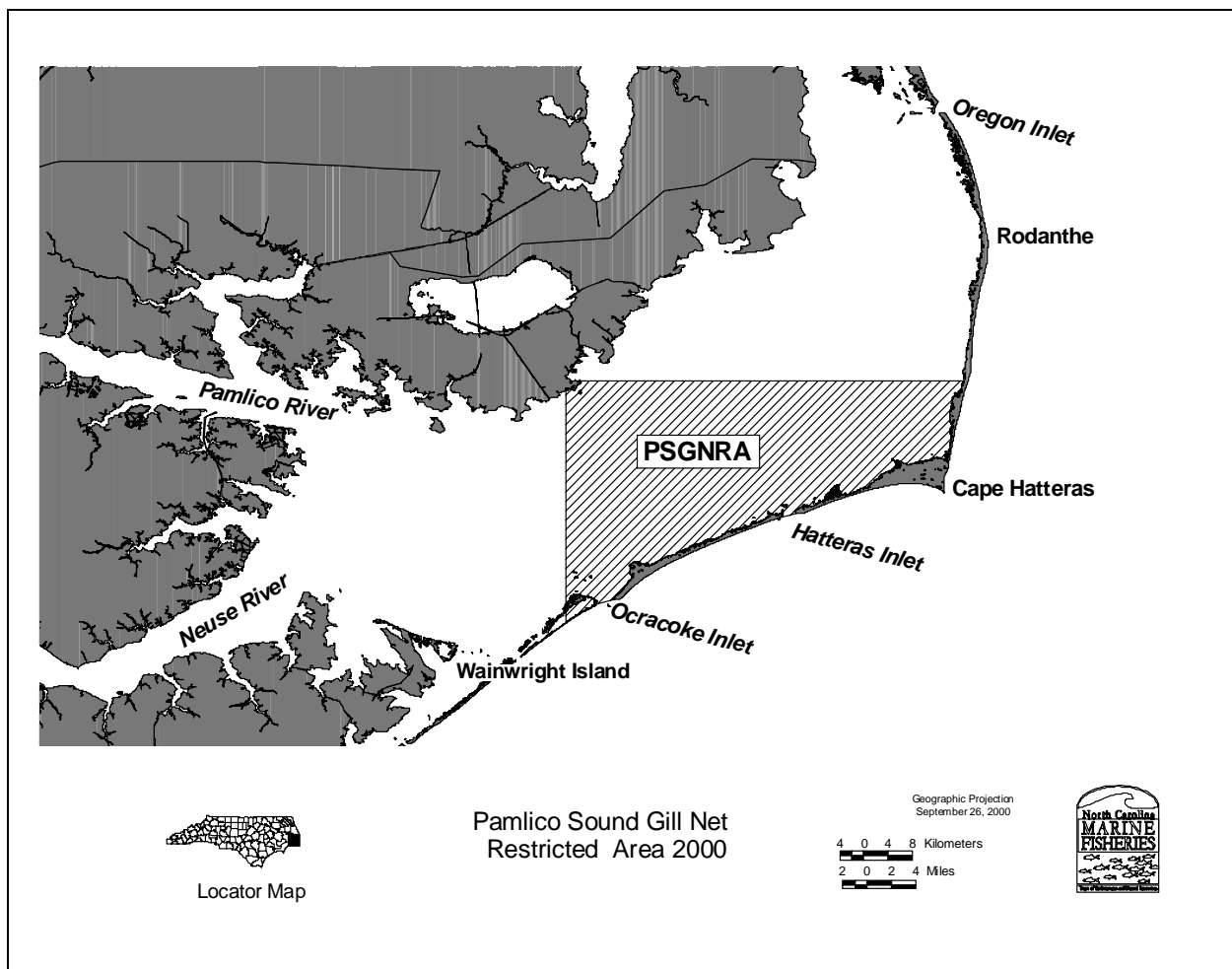


Figure 1. Map of southeastern Pamlico Sound and the 2000 Pamlico Sound Gill Net Restricted Area (PSGNRA).

On October 25, 2000, observed levels of gillnet/sea turtle interactions and strandings reached thresholds specified in the ITP for closure of the large mesh (> 5 inch stretched mesh) gillnet fishery. Subsequently, NCDMF issued Proclamation M-14-2000 closing the PSGNRA to the use of large mesh gillnets effective October 27, 2000. In January 2001, NMFS and NCDMF held a joint meeting to review the data collected during the 2000 fishing season. Eighteen takes were observed, fourteen in the deep water segment of the fishery and four in the shallow water component. Eight of the sea turtles observed in the deep water fishery were dead while one was observed dead in the shallow water component.

Fisheries Description

Monitoring conducted by NCDMF during the 2000 fishing season indicated that the Pamlico Sound large mesh gillnet fishery consisted of two major components. First, a shallow water fishery, which occurred along the Outer Banks and secondly, a deep water component, which operated farther from shore along a slope adjoining the main basin of Pamlico Sound (Figure 2). Both of these fisheries target southern flounder (*Paralichthys lethostigma*). The deep water fishery developed approximately 10 years ago and has steadily expanded since its

inception. Historically, pound nets have landed the majority of North Carolina's southern flounder. However, the development and expansion of the deep water large mesh gillnet fishery in Pamlico Sound during the early 90's caused gillnets to surpass pound nets as the dominant southern flounder fishing gear. Monitoring during the 2000 fishing season also identified two small mesh gillnet fisheries, which operated along the Outer Banks in the same areas that the shallow water large mesh fishery operated.

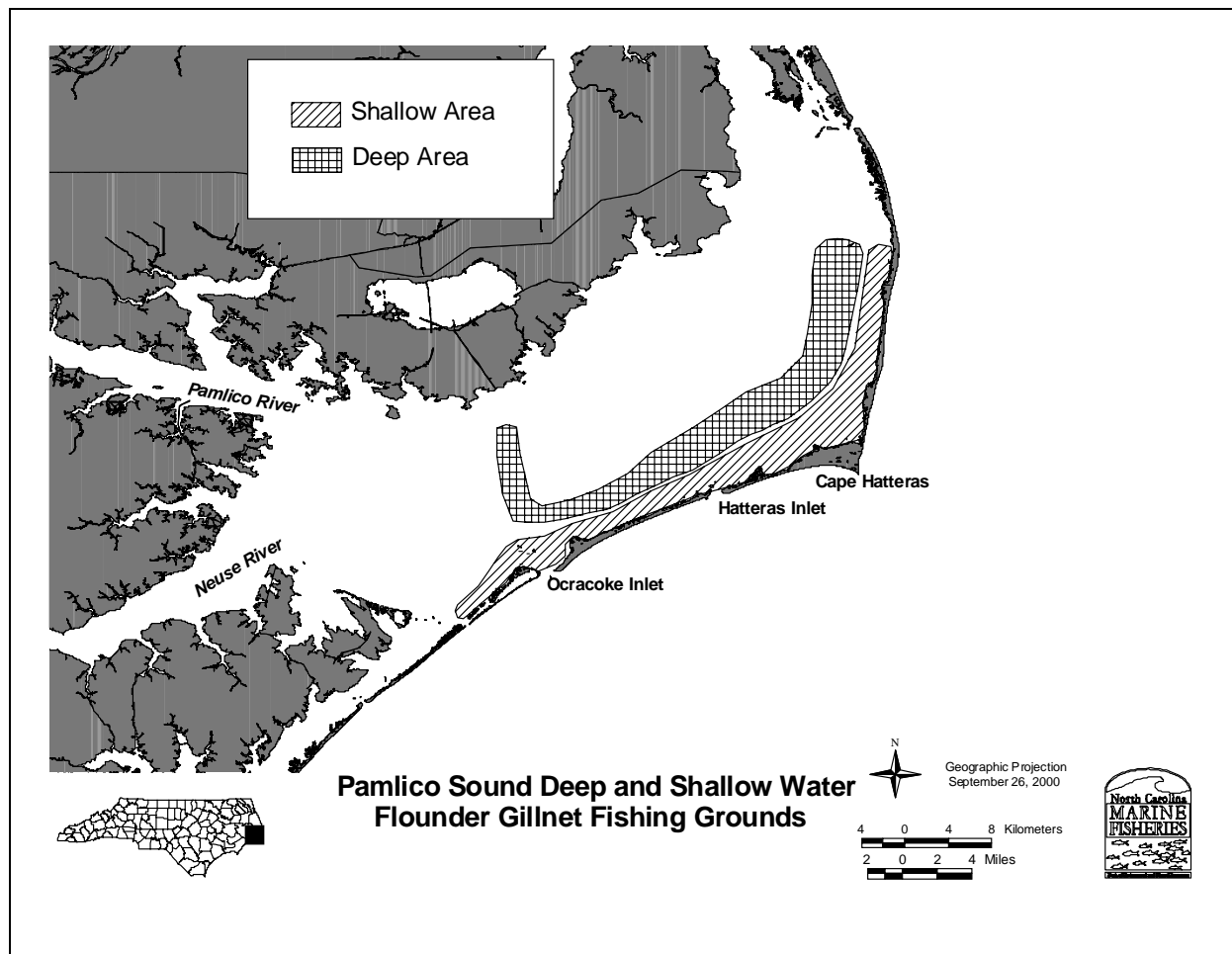


Figure 2. North Carolina estuarine flounder gillnet fishing grounds in southeastern Pamlico Sound.

Deep Water Large Mesh Gillnet Fishery

The deep water fishery operated from September through December with fishermen setting nets along a slope adjacent to the main basin of Pamlico Sound (Figure 2). Fishing depths in this area ranged from 10 to 20 feet. Vessels were typically ocean sink gillnet boats ranging from 25 to 45 feet in length, each with two-man crews. Each fishing operation set between 2,000 and 3,000 yards of large mesh (5.5 to 6.5 inch) gillnet, which were soaked for up to three days and retrieved with the aid of net reels. Sets were composed of 200 to 600 yard lengths of gillnet with most constructed of 0.5 mm twine. Net depths ranged from 8 to 12 feet

with tie-downs 2 to 4 feet long attached to the float and lead lines at 50 feet intervals along the net. Tie-downs were used in this fishery to produce a bag or pocket of webbing, which increased catch efficiency of bottom dwelling flounder (Figure 3). There were 25 active participants in this fishery during the 2000 fishing season with most trips originating from Engelhard or Swan Quarter and a small portion leaving from Hatteras. This fishery developed approximately 10 years ago.

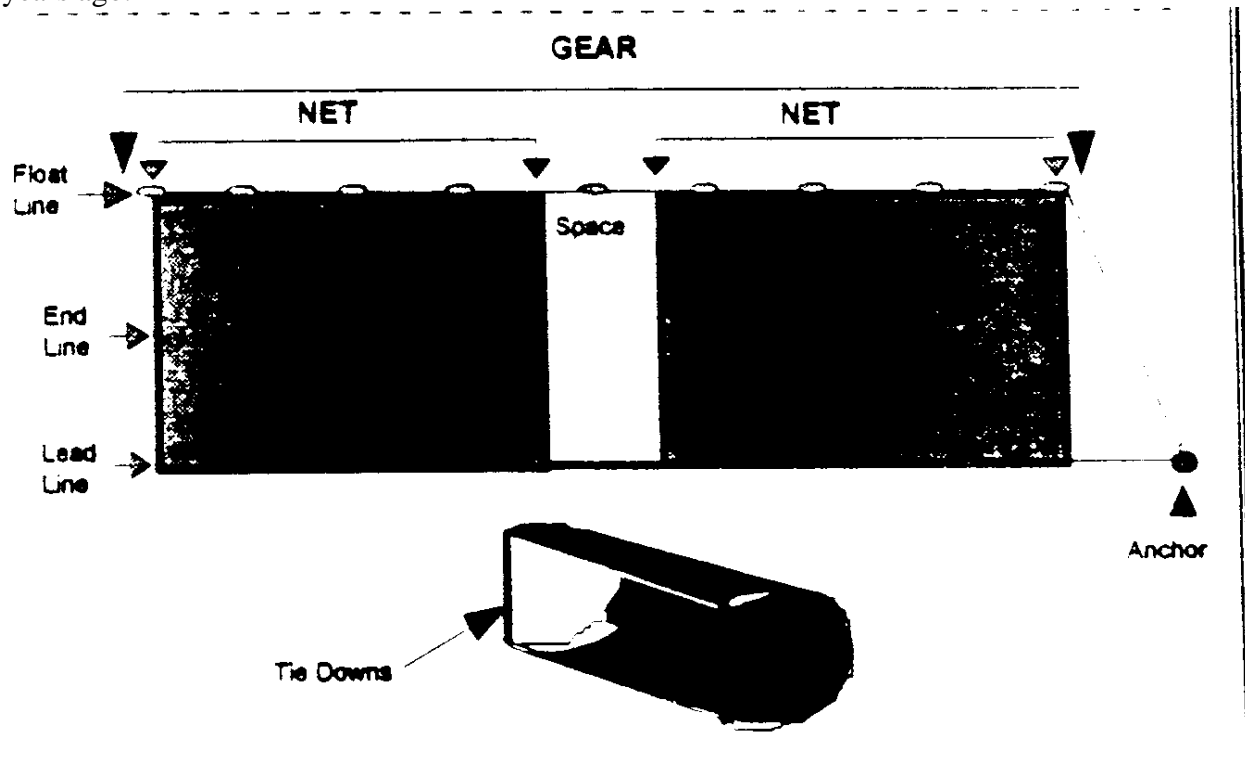


Illustration taken from Fisheries Sampling Branch Observer Manual, NMFS (1996)

Figure 3. Diagram of a sink gillnet. The sink gillnet is submerged below the water line and consists of several net panels attached together as a string. This gear can be modified with tie-downs to target bottom-dwelling fish.

Shallow Water Large Mesh Gillnet Fishery

The shallow water fishery operates from April through December in areas next to the barrier islands in Pamlico Sound (Figure 2). Fishing depths in these areas are typically less than three feet. Vessels are usually open skiffs ranging from 15 to 25 feet in length with one or two man crews. Each fisherman sets 500 to 2000 yards of large mesh (5.5 to 7.0 inch) gillnet, which are soaked overnight and retrieved by hand. Sets are composed of many short lengths of gillnet with most constructed of 0.5 mm twine. Tie-downs are not used in this fishery, but net depths range from 6 to 11 feet with sets occurring in depths less than 3 feet. This combination of water depth and net depth provides the same bag effect as the tie-down in the deep water fishery. Sixty-eight active participants fished within the PSGNRA during the 2000 fishing season. This is the traditional flounder fishery, which extends both north and southwest of the PSGNRA along the Outer Banks.

Shallow Water Small Mesh Gillnet Fishery

The shallow water small mesh fishery is composed of two separate fisheries each with different modes of operation; the “runaround” and “set” gillnet fisheries. The runaround gillnet fishery targets striped mullet (*Mugil cephalus*) and operates year round with most of the effort occurring during the fall from September through November when prices are high due to increased roe content of spawning females. The Pamlico Sound fishery operates in the shallow water areas next to the barrier islands (Figure 2). Vessels are usually open skiffs ranging from 15 to 25 feet in length with one or two-man crews. Fishermen set out in search of schools of striped mullet. Once a school is sighted, one end of the runaround gillnet is deployed with a buoy and a small weight (< 3 lb.). The weight creates drag, which enables the rest of the net to be fed out as the fishermen encircles the school of fish. The net is set in a closed circle and fishes the entire water column. Nets are typically 100 - 1000 yd. in length with a stretched mesh of 3.5 to 4.5 inches. The primary retrieval technique is the open retrieve method where the net is immediately hauled back into the boat starting with the terminal end. A second retrieval technique involves setting only part of the net in a circle and then ‘corkscrewing’ the remainder of the net around inside the circle. This method compresses the fish into smaller areas that forces them to hit the net. Soak times for this fishery are typically less than four hours and nets are attended during the entire operation.

The shallow water small mesh set gillnet fishery operates along the Outer Banks with most of the effort occurring from October through early December. Nets are anchored overnight similar to the large mesh fishery for flounder that occurs in the same area. Vessels are usually open skiffs ranging from 15 to 25 feet in length with one or two-man crews. Each fishing operation sets 500 to 2000 yards of small mesh (3 to 4.5 inch) gillnet, which are retrieved by hand. Sets are composed of many short lengths of gillnet with most constructed of 0.5 mm twine or smaller. Tie-downs are not used in this fishery, but net depths range from 6 to 11 feet with sets occurring in depths less than 3 feet. This combination of water depth and net depth provides the same bag effect as the tie-down in the deep water large mesh fishery. Target species include striped mullet, spotted seatrout, weakfish (*Cynoscion regalis*), and bluefish (*Pomatomus saltatrix*). Sets are made along the sandbar or “reef” the separates the shallow and deep water areas along the barrier islands. In recent years, NCDMF has enacted rules designating small mesh (< 5 inch stretched) attendance areas along the Outer Banks from March 1 through October 31 to minimize red drum bycatch and subsequent discard mortality (Rule 15A NCAC 3J .0103 (h) in NCMFC 2001). This rule requires small mesh gillnet fishermen to remain within 100 yards of their net at all times. Because of this requirement many fishermen set outside of the attendance area just beyond the reef or wait until November 1 to employ this method of fishing when they are no longer required to attend their nets.

METHODS

Results of the 2000 PSGNRA monitoring program indicated that the deep water fishery was responsible for most of the takes and subsequent strandings that occurred during the 1999 and 2000 fishing seasons. During the summer of 2001, NCDMF in consultation with NMFS applied for another ITP (66 FR 42,845, August 15, 2001). The ITP authorized implementation of management measures during the fall of 2001 to protect threatened and endangered sea turtles while allowing both the small and large mesh shallow water gillnet fisheries to be prosecuted

within designated areas of Pamlico Sound. On September 27, 2001, NMFS issued ITP #1348 to NCDMF (66 FR 51,023, October 5, 2001). A key component of the permit was a comprehensive conservation plan. The primary goal of this plan was to reduce sea turtle takes in southeastern Pamlico Sound from September 15 through December 15, 2001.

ITP Conservation Plan

The first action taken by NCDMF was the designation of the PSGNRA from September 15 through December 15, 2001 (Figure 4). After NCDMF designated the PSGNRA, NMFS closed the rest of Pamlico Sound to gillnets with mesh sizes larger than 4.25 inch stretched mesh on September 27 (Figure 4, 66 FR 42,845, August 15, 2001). All fishermen that utilized gillnets in the PSGNRA were required to obtain a permit from NCDMF. Provisions of the permit required a maximum yardage limit of 2,000 yards, mandatory weekly reporting, mandatory sea turtle interaction reporting, and mandatory observer coverage. Two inlet corridors were designated, the Ocracoke Corridor (OC) and the Hatteras Corridor (HC). Corridors to the inlets were closed to large mesh (>5 inch stretched) gillnets and small mesh gillnets fishing anywhere in the PSGNRA were required to attend their nets until November 1. A few weeks into the season on October 5, an area just south of Oregon Inlet was also designated as a corridor by NCDMF and large mesh gillnets were prohibited in this area for the remainder of the season.

Permit Reporting

Permitted fishermen were required to provide weekly reports to NCDMF. The following information was provided by each fishermen for each gillnet fishing trip conducted within the PSGNRA between September 15 and December 15, 2001.

- Port of landing
- Restricted area fished
- Total lbs and lbs of flounder landed
- Yards of either large or small mesh gillnet fished
- Soak time in days
- Number of sea turtles caught
- Condition of sea turtles caught

Reports were submitted to NCDMF by 6:00 p.m. on Sunday during each week of the fishing season. Failure to comply with these reporting requirements or providing false information resulted in permit suspension. In addition, fishermen were required to report all sea turtle interactions to NCDMF within 24 hours. Penalties for non-reporting were:

- | | |
|--------------------------------|--------------------|
| • First offense non-reporting | 10 day suspension |
| • Second offense non-reporting | 30 day suspension |
| • Third offense non-reporting | 6 month revocation |

Penalties for late reporting were:

- | | |
|---------------------------------|--------------------------------|
| • First offense late reporting | Courtesy call & Warning letter |
| • Second offense late reporting | 10 day suspension |
| • Third offense late reporting | 30 day suspension |
| • Fourth offense late reporting | 6 month revocation |

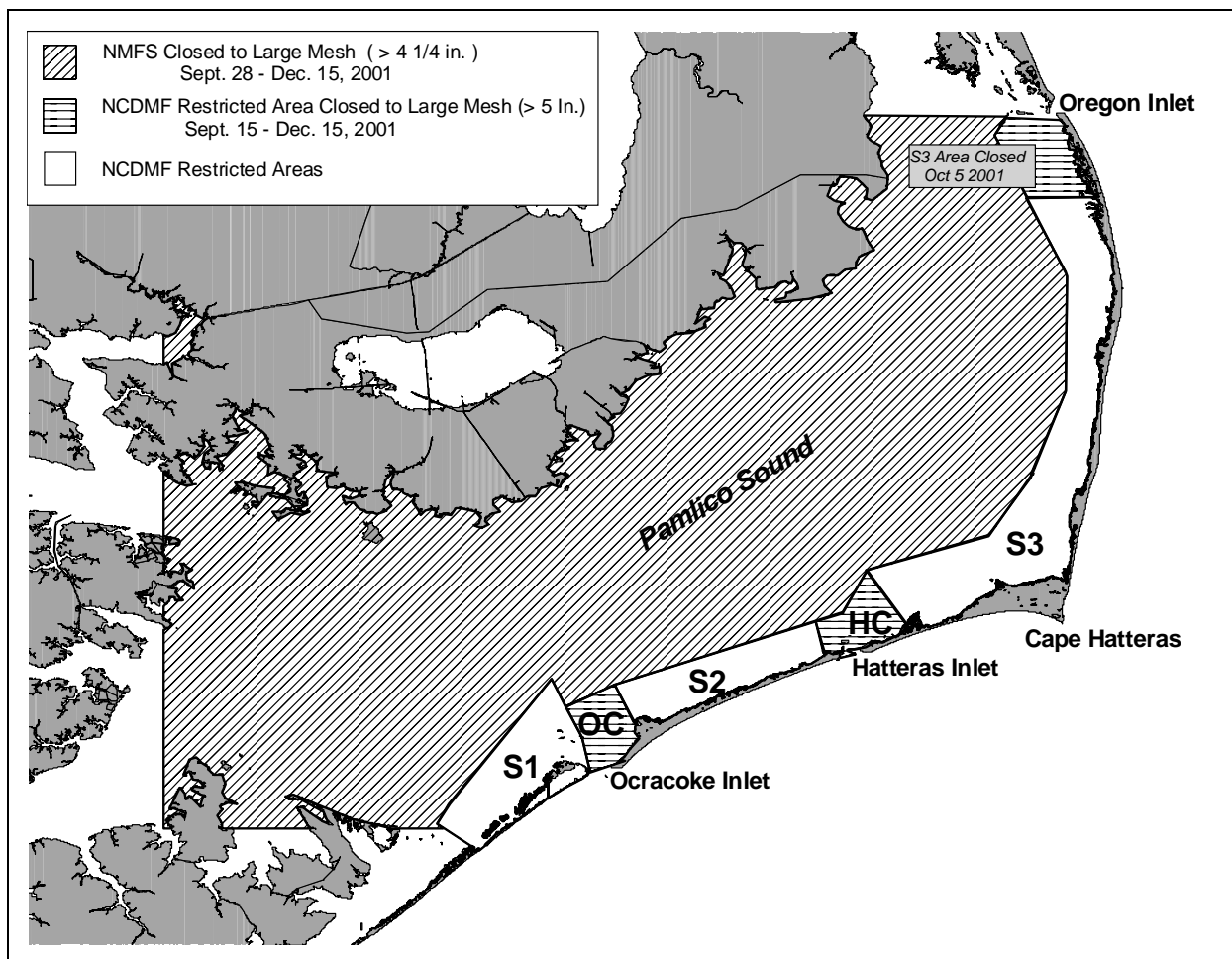


Figure 7. NCDMF 2001 Pamlico Sound Gillnet Restricted Area (PSGNRA) and NMFS closed area. S1=Shallow Water Gillnet Restricted Area 1; S2=Shallow Water Gillnet Restricted Area 2; S3=Shallow Water Gillnet Restricted Area 3; OC=Ocracoke Inlet Corridor; HC=Hatteras Inlet Corridor.

Sea Sampling

The PSGNRA permit also established mandatory observer coverage for the gillnet fisheries. Permit holders were required to allow NCDMF fishery observers aboard their vessels to monitor catches. Failure to comply with this permit provision resulted in permit suspension. Observers were randomly assigned and proportionally allocated by port, which included Wanchese, Rodanthe, Avon, Buxton, Frisco, Hatteras, Ocracoke, Cedar Island and Atlantic. The goal of the observer program was to provide 10% coverage of all large mesh gillnet trips from September 15 through December 15 and 10% coverage of all small mesh trips conducted between September 15 and October 31 and 20% coverage of small mesh trips conducted after the small mesh attendance requirement was lifted from November 1 through December 15.

NMFS provided funding for an NCDMF observer program, which consisted of existing NCDMF employees and employees hired through a temporary agency. Each observer was trained to identify, measure, resuscitate, and tag sea turtles. Date, time, tag numbers, location

(latitude and longitude, when possible), condition (e.g., no apparent harm, injury including a description of the nature of the injury, or mortality), species, sex (if determinable), and curved carapace length were recorded for each turtle observed. Dead sea turtles were brought to shore when feasible. All live, debilitated sea turtles were brought to shore for examination and treatment. Carcasses not brought in for post-mortem examinations were marked with external flipper tags or spray-painted before disposal overboard. Observers collected data on location, gear parameters, catch, and bycatch for each haul. The landed catch was sampled throughout each trip and total flounder weights were obtained. Data were coded on NCDMF data sheets, double keyed, proofed, and loaded into the NCDMF Biological Database for analysis. All observers were debriefed within 24 hours of each trip to collect data on flounder catch, total catch, set locations, gear parameters, and sea turtle interactions.

The total bycatch of sea turtles in the PSGNRA was estimated using the stratified ratio method. The bycatch rate (sea turtles caught per unit of fishing effort), estimated from observer data, was multiplied by the total fishing effort reported by the fishermen for each fishery. The strata were spatially defined by the restricted areas S1, S2, S3, OC, HC. Fishing effort was the product of yards and soak time (days). Total bycatch estimates were calculated weekly by adding estimates for each fishery within each restricted area.

Management Measures

During the 2000 fishing season, a multilevel management approach was devised to achieve the goal of 50% reduction of sea turtle strandings during the 2000 fishing season relative to the 1999 season. Four levels of management were established based on total sea turtle bycatch estimates and strandings. Maximum stranding levels were set by species and reflected 50% reductions for each. The assumption that one in four turtles that were killed at sea reach shore was used to calculate the total allowable lethal takes for the 2000 fishing season. In addition, 50% discard mortality was assumed for the large mesh gillnet fishery. This mortality estimate was used to calculate the total allowable live takes. Maximum bycatch estimates were set by species for both live and lethal takes (Table 1).

Table 1. Number of sea turtle strandings by species from September 15 through December 15, 1999 in southeastern Pamlico Sound, North Carolina and maximum allowed strandings, estimated lethal takes, and estimated live takes for the same time period and area during the 2000 fishing season.

Species		1999 Strandings	2000 Max. Strandings	2000 Max. Estimated Lethal Takes	2000 Max. Estimated Live Takes
Kemp's Ridley	<i>(Lepidochelys kempii)</i>	46	24	96	192
Green	<i>(Chelonia mydas)</i>	20	9	36	72
Loggerhead	<i>(Caretta caretta)</i>	31	14	56	112
Species Aggregate		97	45	175	350

The stranding and take levels listed in Table 1 were utilized to trigger the fourth and final management response, which consisted of closing the PSGNRA to large mesh (> 5 inch stretched mesh) gillnets. Three other levels, which theoretically should have been reached before the fourth level, were also calculated. During the 2000 fishing season, the fourth level

was reached before any of the other management levels leaving little flexibility in the management response. So for the 2001 fishing season, the total allowed number of estimated lethal and live takes were calculated for a final close down management strategy with no intermediate management levels (Table 2).

Table 2. Maximum allowed estimated lethal takes and live takes by species from September 15 through December 15 for the PSGNRA during the 2001 fishing season.

Species	2001 Max. Estimated Lethal Takes	2001 Max. Estimated Live Takes
Kemp's Ridley	24	164
Green	24	164
Loggerhead	24	164
Species Aggregate	72	492

The single level approach was selected because it was more conservative. Also, strandings were not used as a measure of management effectiveness during the 2001 season due to the variability associated with these types of data. The 2001 allowable take was based on the 2000 allowable take, which represented a 50% reduction in gillnet mortality compared to 1999. The differences between the 2000 and 2001 fishing seasons were:

- Elimination of the deep water flounder gillnet fishery
- Expansion of the shallow water flounder gillnet fishing area covered by the permit
- Inclusion of the shallow water small mesh gillnet fishery in the expanded area

To arrive at the new allowable take levels several assumptions were made. First, the overall take was expected to remain constant because the deep water fishery, which uses more net and longer soak times than the shallow water fishery was eliminated. At the same time the shallow water area was expanded, and the small mesh fishery was included. Therefore, the amount of gear and subsequent interactions were expected to remain approximately the same. The 2000 data indicated that the deep water fishery produced more lethal interactions than the shallow water fishery. While the interactions were assumed to remain constant, the number of lethal interactions was expected to decrease because the deep water fishery was eliminated.

The shallow water large mesh fishery was assumed to be half as lethal as the deep water large mesh fishery because of the shorter soak times and depth of water fished, which allows captured turtles to reach the surface. The shallow water small mesh fishery was assumed to be half as lethal as the shallow water large mesh fishery because attendance was required for half the season resulting in even shorter soak times. Assuming 50% release mortality for the deep water fishery, the new expected mortality rate for the PSGNRA fisheries was 12.5%. Applying this rate to the total number of takes allowed in the 2000 ITP (564) results in 493 live takes and 71 lethal takes for all species. NCDMF and NMFS could not agree upon the species breakdown of these numbers because the species composition of sea turtles observed in NMFS pound net surveys in the area did not reflect the species composition of the observed takes in the NCDMF 2000 monitoring program. The allowable take was divided equally among the three most common species, which resulted in 164 live takes and 24 lethal takes for each species. Additionally, two observed takes of both Leatherback (*Dermochelys coriacea*) and Hawksbill (*Eretmochelys imbricata*) sea turtles were allowed.

Gear Testing

In addition to the observer program implemented in the PSGNRA, NCDMF also evaluated two modified low profile gillnets in the NMFS closed area on traditional deep water flounder gillnet fishing grounds. The closure of this area to large mesh gillnets resulted in significant economic hardship to North Carolina Pamlico Sound gillnet fishermen and has shifted fishing effort into other coastal North Carolina fisheries causing gear conflicts and increased effort on other NCDMF/ASMFC managed species. The identification of a modified flounder gillnet that prevents the bycatch of sea turtles and reduces bycatch of other species while maintaining an acceptable level of flounder landings would allow this highly productive fishing area to be reopened, while averting user conflicts in adjacent fisheries and providing financial relief to those fishermen affected by the closure.

Sea turtle strandings in southeastern Pamlico Sound during the fall of 1999 were associated with the Pamlico Sound deep water flounder gillnet fishery, which used large mesh gillnets with tie-downs to produce a bag or pocket of webbing, which increased catch efficiency of bottom dwelling flounder. The following spring another stranding event occurred on northern North Carolina beaches and several turtles washed up with pieces of gillnet attached. Inspection of the gear indicated that the monkfish (*Lophius americanus*) fishery was responsible for at least a portion of the strandings. The monkfish fishery also uses large mesh (12 to 14 inch stretched) gillnets with tie-downs.

The implication of these two large mesh tie-down gillnet fisheries prompted NCDMF and NMFS to conduct an experiment designed to determine the turtle entanglement potential of three large mesh gillnet configurations with varying tie-down lengths. Results of the 2000 study indicated that entanglement rate increased as panel height decreased (Table 3). Additionally, the turtle escapement rate, for turtles that entangled in the net but escaped, decreases with the length of tie-down (Table 3). No difference was found among nets and between group testing indicated differences between the control and 2/3 tie-down net.

Table 3. Sea turtle entanglement rates for three tie-down gillnet configurations.

Treatment	Panel Height	Depth of Pocket	n	Entanglement Rate	Entangled/Escaped Rate
Control Net	6 feet	0	42	47.6%	31.0%
1/3 Tie-Down Net	4 feet	1 foot	42	54.8%	25.0%
2/3 Tie-Down Net	2 feet	2 feet	41	68.3%	12.5%

Based on these results NCDMF conducted further testing of the control net configuration without tie-downs and a new double leadline configuration during the 2001 fall flounder fishing season. The control net in the 2001 study was a standard deep water flounder gillnet with a panel height of approximately 12 feet with 3 to 4 feet tie-downs placed at regular intervals throughout the net (Table 4). This was equivalent to the 2/3 tie-down treatment in the 2000 study, which had the highest entanglement rate and the lowest escapement rate (Table 3). The first experimental gillnet configuration tested was a low-profile net that had panel height of six feet, half the height of the control net, with no tie-downs (Table 4). This was equivalent to the control net in the 2000 study, which had the lowest entanglement rate and highest escapement

rate (Table 3). The second experimental net was a double leadline configuration with the float line of the net replaced by another leadline. All other characteristics except hanging ratio, were the same as the control net including panel height (Table 4). Because the net lacked a pocket or wall of webbing, this net fished by entangling not bagging as in the tie-down gillnets design. The net was hung 2/3 instead of the normal 1/2 ratio, which supplied more webbing for entanglement enabling the net to catch better.

Table 4. Net characteristics of three types of net evaluated in southeastern Pamlico Sound during the 2001 flounder gillnet season from October 19-December 4.

Net Characteristics	Control	Low Profile	Double Leadline
Webbing			
Mesh Size (in)	6	6	6
Twine Size(mm)	0.57	0.57	0.57
Panel Height (ft)	12	6	12
Hanging Ratio	1/2	1/2	2/3
Floatline	1 per 2 fathoms	5/16" Poly Line	65 lb/100 fathom
Leadline	65 lb/100 fathom	65 lb/100 fathom	65 lb/100 fathom
Tie-Down	3 feet every 4 fathoms	None	None

Thirty trips were conducted between October 19 and December 4, 2001 on traditional deep water flounder gillnet fishing grounds in southeastern Pamlico Sound. A commercial vessel was contracted to set and retrieve hauls. Nets were soaked overnight and retrieved daily. A randomized block design was used to facilitate comparisons among nets. Each net type was randomly assigned to a position within each of three separate hauls. Each haul contained a 300 yard length of each net type for a total of 900 yards per haul. Three hauls were set and retrieved during each trip for a total of 2700 yards fished per trip. Each haul was set in a traditional manner, perpendicular to shore just outside of the PSGNRA. An NCDMF observer was present during each trip and collected location, catch and bycatch information for each net type within each haul. Twelve live and five lethal sea turtle takes of any species were allowed for the duration of the study.

RESULTS

Gillnet fishery monitoring began September 15, 2001 and ended December 15, 2001. Monitoring consisted of assigning permits, collecting logbook reports, and deploying observers in the large and small mesh gillnet fisheries. All reporting and observer deployment and debriefing were done weekly to provide timely estimates of sea turtle bycatch.

Permit Reporting

There were 209 PSGNRA permits issued during the thirteen-week season with 126 participants reporting fishing activity. Compliance with reporting requirements was satisfactory with only 3.5% failing to report and 10.7% reporting late (Figure 5). Only 0.9% of the reports

are still outstanding. During the first three weeks of the season, NCDMF staff assisted permittees with reporting compliance by calling to remind them. After the third week, no effort was made to remind fishermen of their reporting requirements and consequently non-compliance increased sharply (Figure 5). In the eleventh week, a staff member called to remind permittees and late reporting for that week was very low (Figure 5). Over the entire season, 130 warning letters were sent out for first offense late reporting and 132 permit suspensions were issued for both multiple offense late and non-reporting.

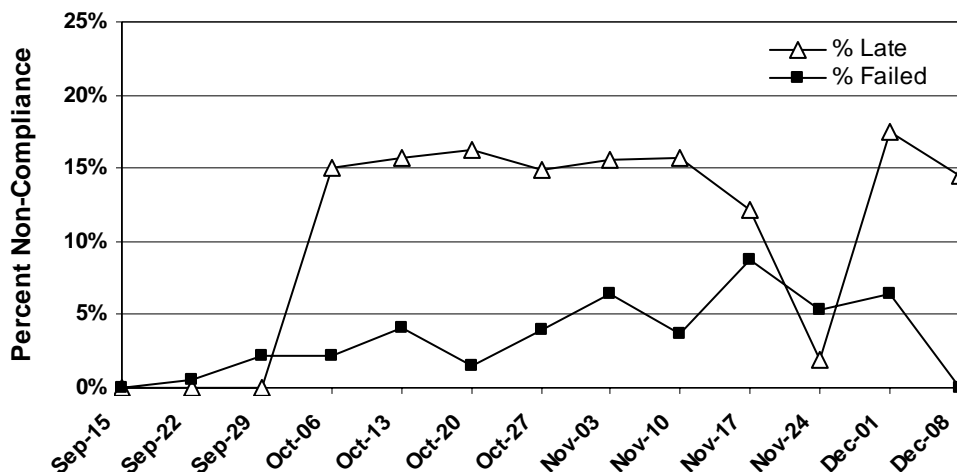


Figure 8. Percent late and failed PSGNRA permit reporting by week for the 2001 fishing season.

Fishing Activity

Inactive permits outnumbered active permits throughout the season (Figure 6). Many fishermen feared a limited entry management approach and obtained a permit but never fished within the PSGNRA. This large number of inactive participants inflated the number of noncompliant permit reporters with greater than 95% of the late and failed reports represented by inactive permits. For active permits, large mesh permits far outnumbered small mesh permits until mid November (Figure 7). Ninety-five permittees reported large mesh gillnet activity and 61 reported small mesh activity with 30 of the active participants reporting both large and small mesh fishing activity. Large mesh fishing activity peaked during the second week and steadily declined over the remainder of the season (Figure 7). Small mesh fishing activity remained steady until the first week of November when effort increased slightly (Figure 7). Much of the small mesh fishing activity before November 1 consisted of attended runaround gillnets while most trips after November 1 were unattended set net trips. The small mesh gillnet attendance requirement before November 1 caused this abrupt shift in fishing mode and the subsequent increase in small mesh fishing activity during November.

Large mesh participants and trips peaked during the second week and steadily declined over the remainder of the season with over 200 trips per week completed at the beginning of the season and less than 20 per week at the end (Figures 8 and 9). Large mesh flounder landings exhibited the same trend with peaks during the first, third, and seventh week (Figure 10). The majority of the fishing activity and subsequent landings occurred in S3, which was the largest area fished (Figures 8, 9, and 10). The number of small mesh participants remained

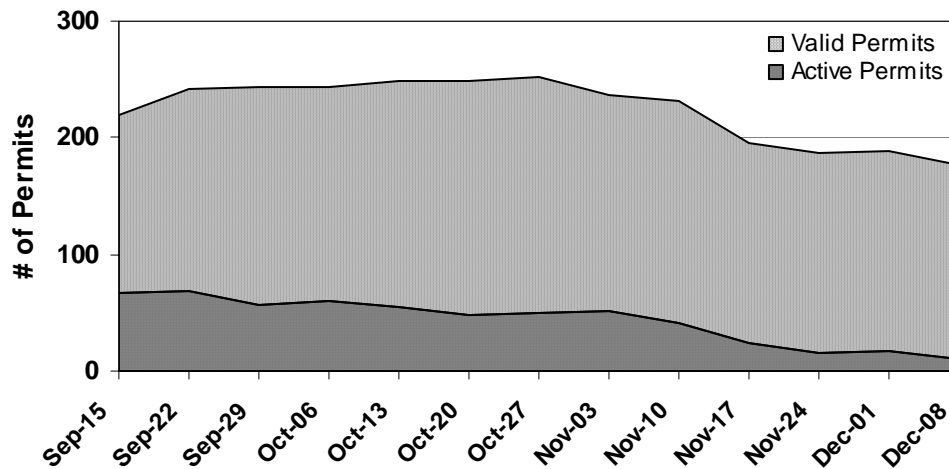


Figure 9. Number of valid and active PSGNRA gillnet permits by week for the 2001 fishing season.

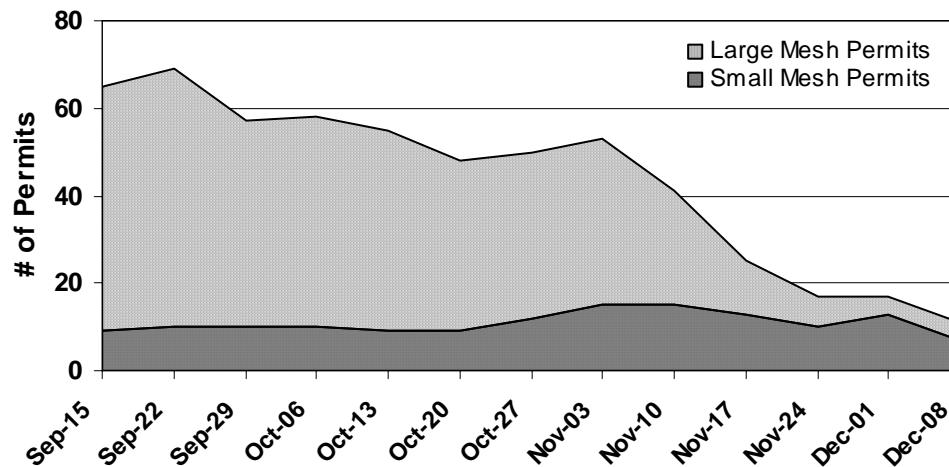


Figure 10. Number of active large and small mesh gillnet permits by week for the 2001 fishing season.

nearly constant throughout the season with a slight increase after November 1 (Figure 11). Prior to November 1, participants and trips in S1 and S2 were nearly equal to the number in S3 (Figures 4, 11, and 12). After the attendance requirements were lifted on November 1, the number of trips increased significantly with most trips occurring in S3 (Figures 4 and 12). Most of these trips were set net trips targeting striped mullet. Prior to November 1, small mesh landings were extremely variable with large peaks during the first, fourth, and seventh weeks (Figure 13). Most of these trips consisted of runaround gillnet trips targeting striped mullet. During this time, small mesh gillnet fishermen reported either large or zero mullet catches. Many fishermen commented that the mullet were occurring in a few large schools rather than many small ones. This probably contributed to the high variability in the catch rates. After November 1, landings stabilized with most reported from S3, which also had most participants and trips of the three areas (Figures 4, 12, and 13).

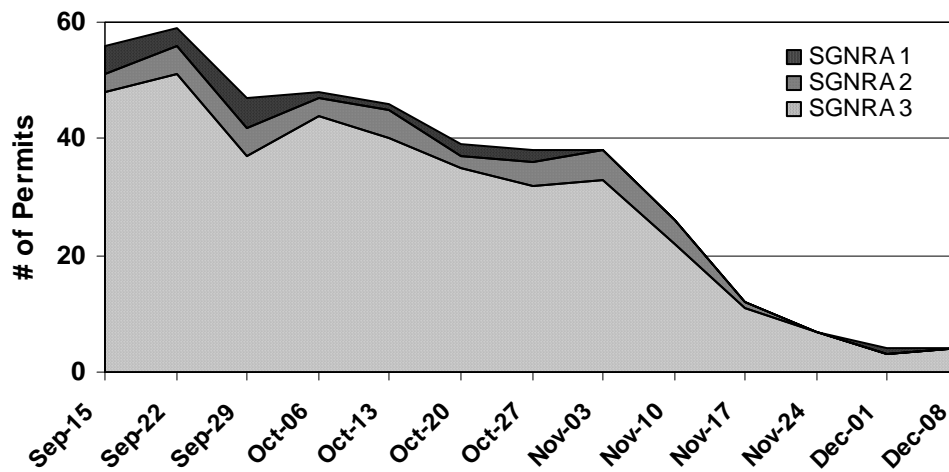


Figure 11. Number of PSGNRA permittees reporting large mesh fishing activity by area and week for the 2001 fishing season.

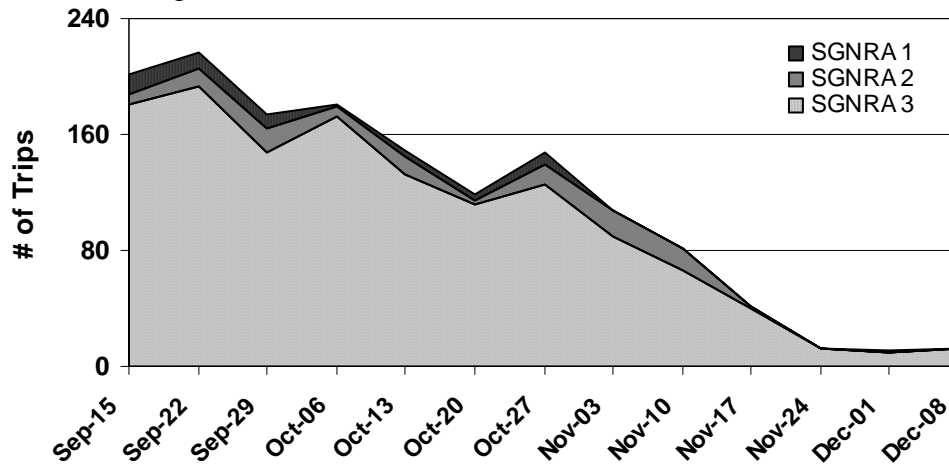


Figure 12. Number of PSGNRA large mesh gillnet trips reported by area and week for the 2001 fishing season.

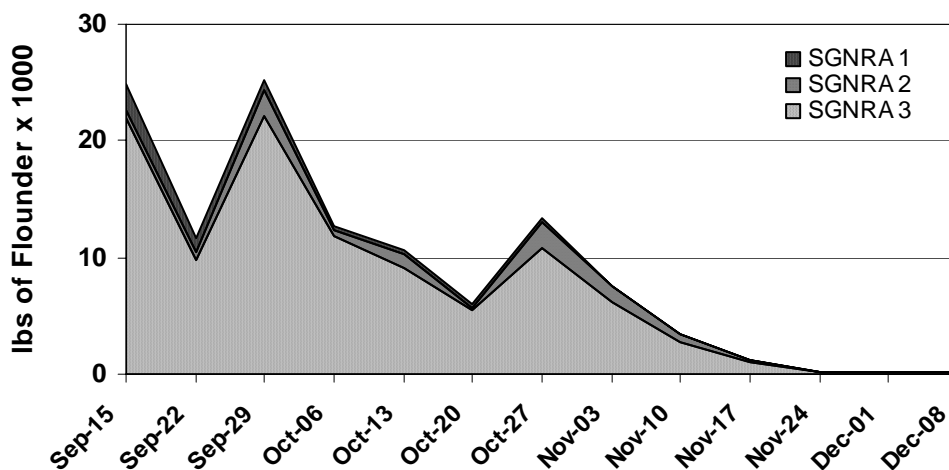


Figure 13. Flounder landings reported by PSGNRA large mesh gillnet fishermen by week and area for the 2001 fishing season.

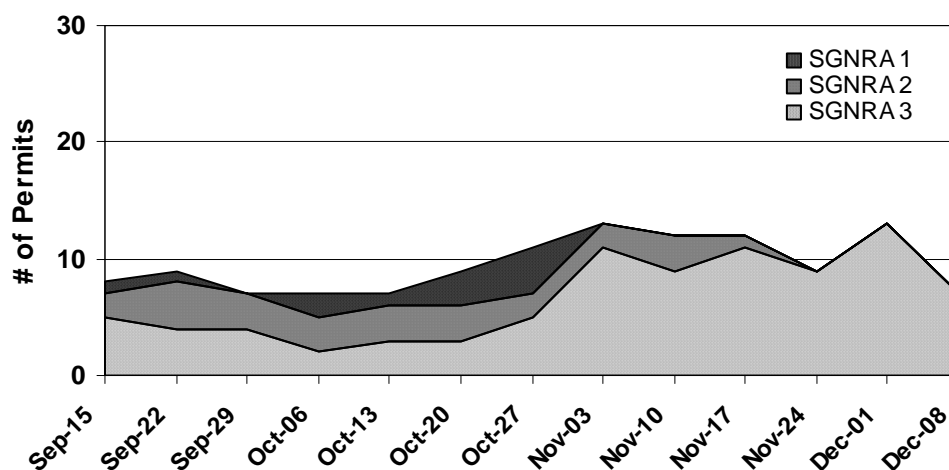


Figure 14. Number of PSGNRA permittees reporting small mesh fishing activity by area and week for the 2001 fishing season.

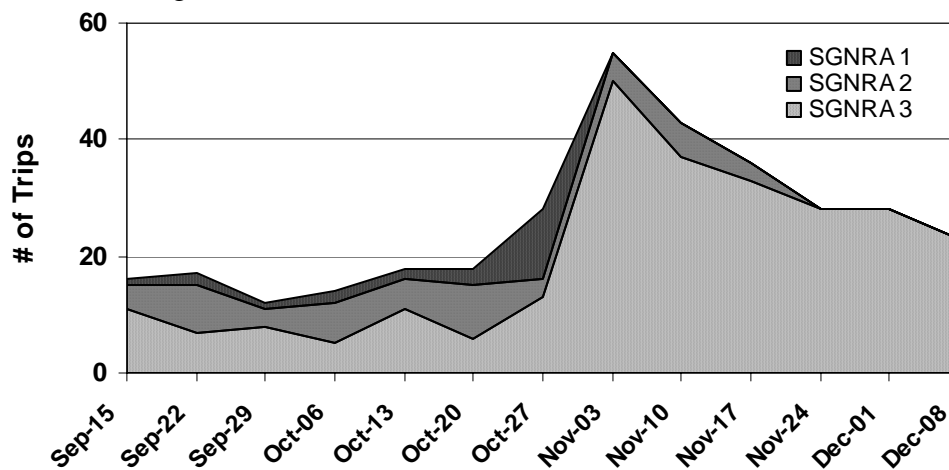


Figure 15. Number of PSGNRA small mesh gillnet trips reported by area and week for the 2001 fishing season.

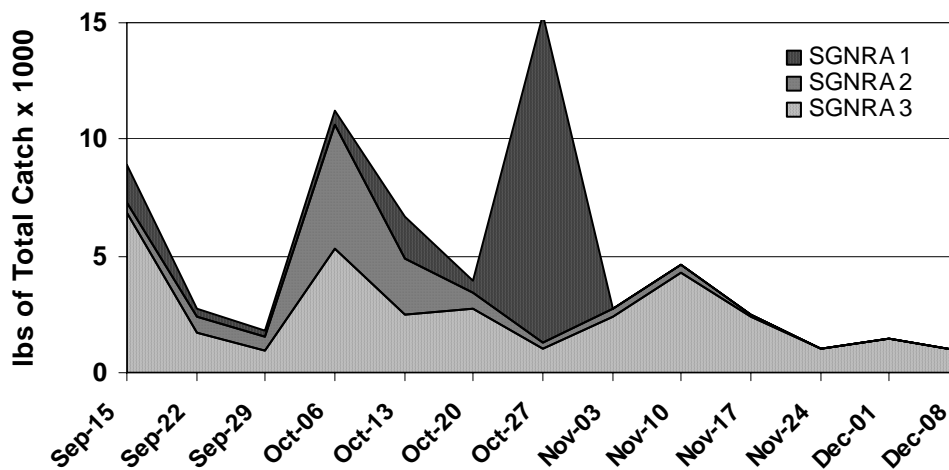


Figure 16. Total landings reported by PSGNRA small mesh gillnet fishermen by week and area for the 2001 fishing season.

Sea Sampling

Observer trips totaled 190 during the 2001 fishing season, including 131 large mesh and 59 small mesh trips. Twelve small mesh trips were conducted before November 1, while 47 were conducted after November 1. Fishermen reported 1,456 large mesh trips, 143 small mesh trips before November 1, and 235 small mesh trips after November 1. This equates to 9% coverage of the large mesh fishery, 8.4% of the small mesh fishery prior to November 1 and 20% coverage of the small mesh fishery after November 1 (Figures 14 and 17). Coverage of fishing effort (yards x soak days), was similar to coverage of trips with large mesh fishermen reporting 1,867,329 yards/soak day and observers sampling 148,784 yards/soak day for 8% coverage (Figure 15). Small mesh fishermen reported 68,500 yards/soak day prior to November 1 and 233,450 yards/soak day after November 1 (Figure 18). Observers sampled 4,740 yards/soak day before November 1 for 6.9% coverage and 49,408 yards/soak day after November 1 for 21.2% coverage (Figure 18). Coverage of landings, an often used measure of fishing effort, was slightly less for the large mesh fishery with fishermen reporting 116,990 lbs of flounder and observers sampling 8,135 lbs of flounder for 7% coverage (Figure 16). Small mesh landings and subsequent coverage were variable with fishermen reporting 54,006 lbs of total catch before November 1 and 15,225 lbs of total catch after November 1 (Figure 19). Observers sampled 3,939 lbs of total catch prior to November 1 for 7.3% small mesh coverage and observed 2,148 after November 1 for 14.1% coverage (Figure 19). Coverage of each fishery appeared to be adequate with observed gear effort (yards x soak days) and CPUEs tracking closely with reported gear effort and CPUEs (Figures 20 and 21). Representative samples of small mesh fishery landings prior to November 1 were difficult to obtain due to the highly variable catch rates of runaround gillnets, which were the primary fishing mode during this time period (Figures 19 and 21). Additionally, few fishermen were employing small mesh gillnets prior to November 1 making it more difficult to locate and observe these trips (Figure 17). The same was true for large mesh gillnets toward the end of the season with fewer fishermen targeting flounder during the last few weeks resulting in less representative sampling (Figures 14 and 20).

Gear effort (yards x soak days) was the least variable measure of fishing effort when compared with landings (Figure 22). This was particularly true for the large mesh fishery and small mesh set net fishery after November 1. Catches and yards fished varied considerably for runaround small mesh gillnets prior to November 1 resulting in high CVs for the small mesh fishery during this time period. These results are similar to those observed during 2000 monitoring, which identified gear effort as the least variable and most accurate measure of fishing effort (Gearhart 2001).

Gear Parameters

Mesh sizes observed in the large mesh fishery ranged from 5 to 7.5 inch stretched mesh with most fishermen using 6 inch (Table 5). Small mesh set nets ranged from 3.13 to 4.5 inch and averaged 3.81 inch, while mesh sizes for runaround gillnets were 3.13 to 4 inches and averaged 3.76 (Table 5). Twine sizes for all three fisheries averaged around 0.5 mm and mean net depths for large mesh set nets and small mesh runaround nets were approximately 10 feet (Table 5). Mean small mesh set net depth was 6.5 feet (Table 5). Mean soak times for the set net fisheries were 24 hours and ranged up to 3 days, while runaround gillnets averaged just under 1 hour and ranged to 2 hrs (Table 5). Yards fished varied with the large mesh fishery ranging

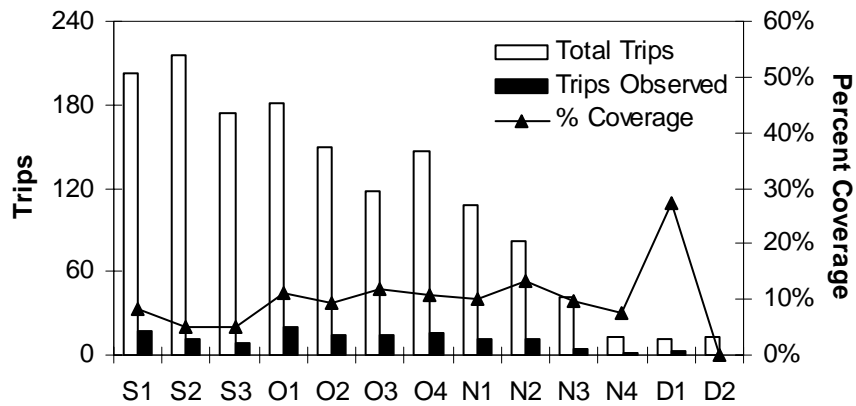


Figure 17. Large mesh trips observed (131), total trips reported (1,456), and observer coverage by week for the 2001 fishing season.

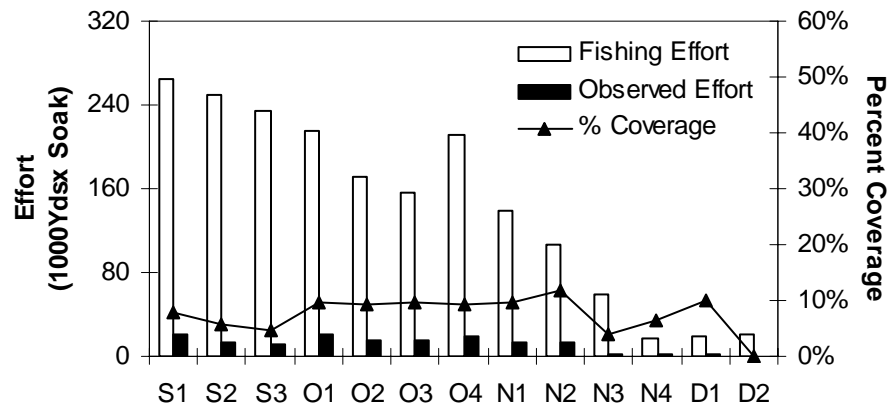


Figure 18. Large mesh effort observed (148,784 yards/soak day), total fishing effort reported (1,867,329 yards/soak day) and observer coverage by week for the 2001 fishing season.

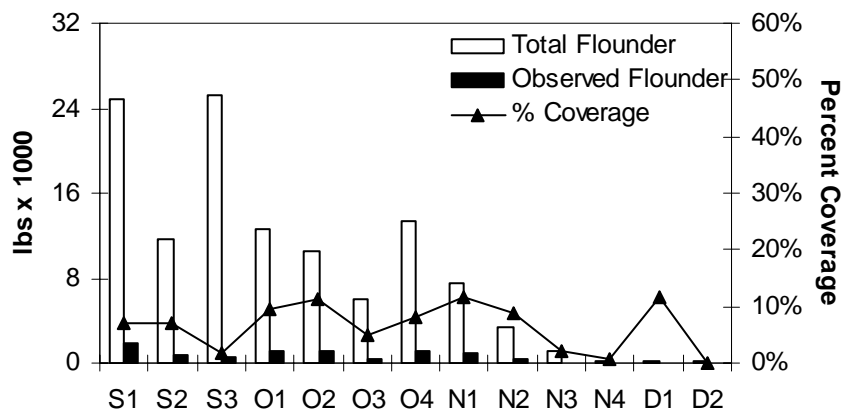


Figure 19. Large mesh pounds of flounder observed (8,135 lbs), total pounds of flounder reported (116,990 lbs), and observer coverage by week for the 2001 fishing season.

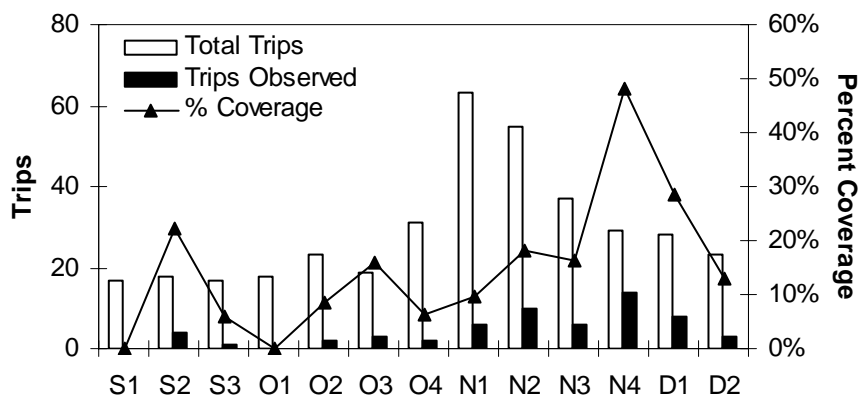


Figure 20. Small mesh trips observed (59), total trips reported (378), and observer coverage by week for the 2001 fishing season.

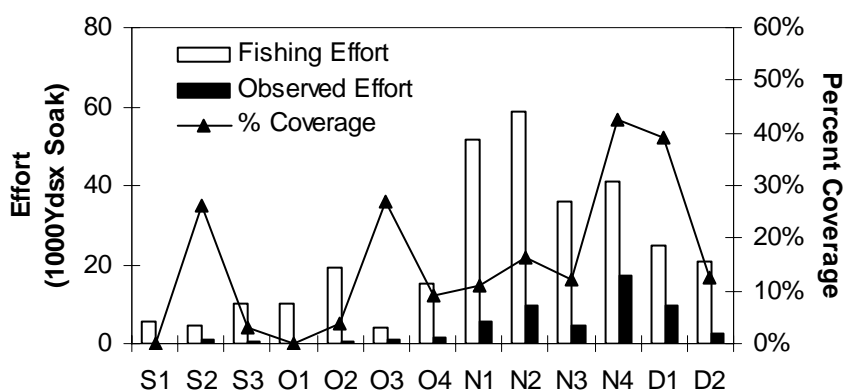


Figure 21. Small mesh effort observed (54,148 yards/soak day), total fishing effort reported (301,950 yards/soak day) and observer coverage by week for the 2001 fishing season.

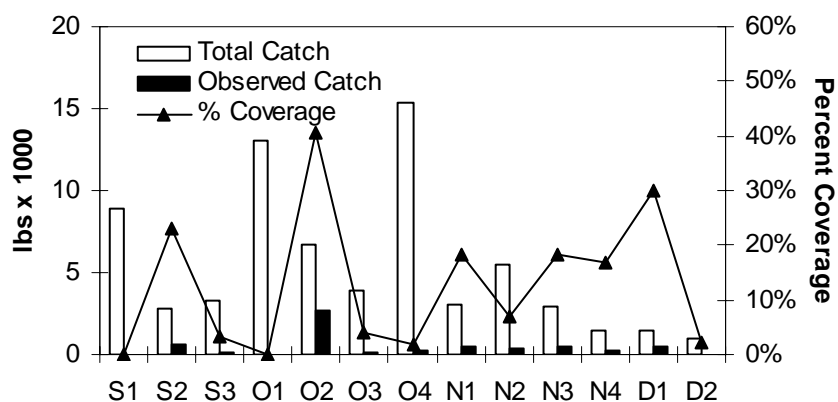


Figure 22. Small mesh pounds of total catch observed (6,087 lbs), pounds of total catch reported (69,231 lbs), and observer coverage by week for the 2001 fishing season.

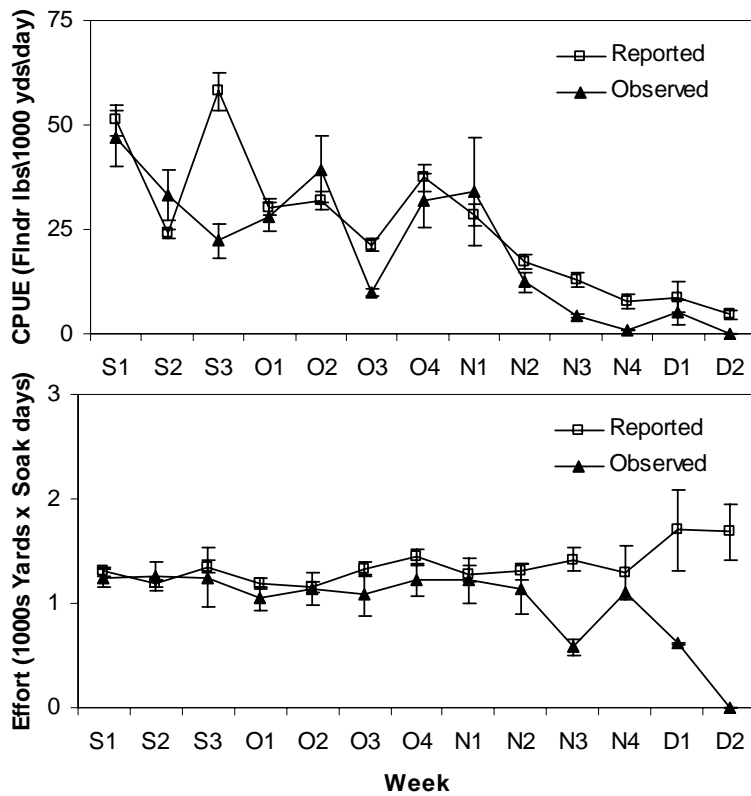


Figure 23. Large mesh observed and reported mean CPUEs (lbs of flounder\1000 yards\day) and mean gear effort (yards x soak days) by week for the 2001 fishing season. Error bars represent standard deviations of the weekly means.

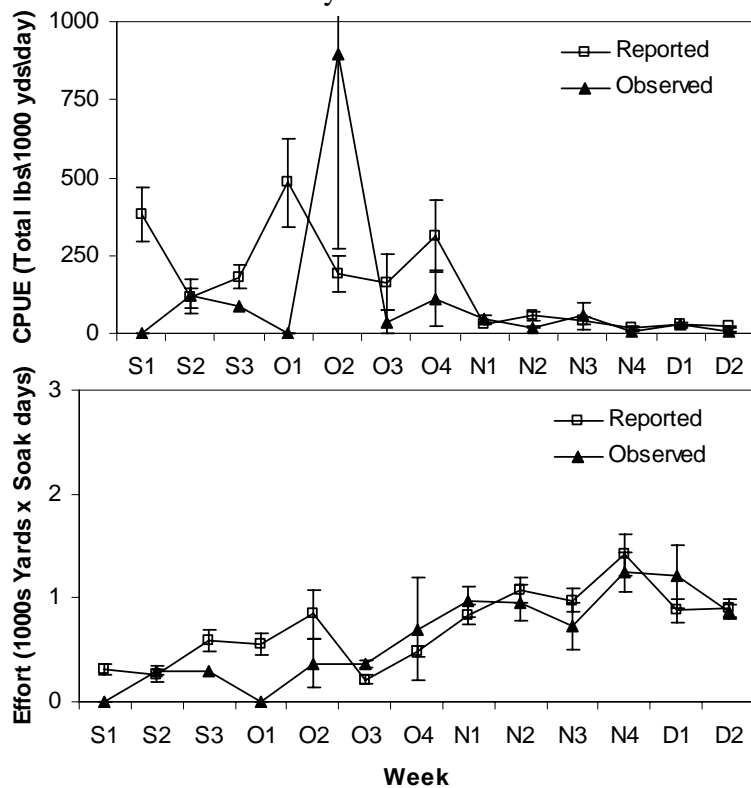


Figure 24. Small mesh observed and reported mean CPUEs (total lbs\1000 yards\day) and mean gear effort (yards x soak days) by week for the 2001 fishing season. Error bars represent standard deviations of the weekly means.

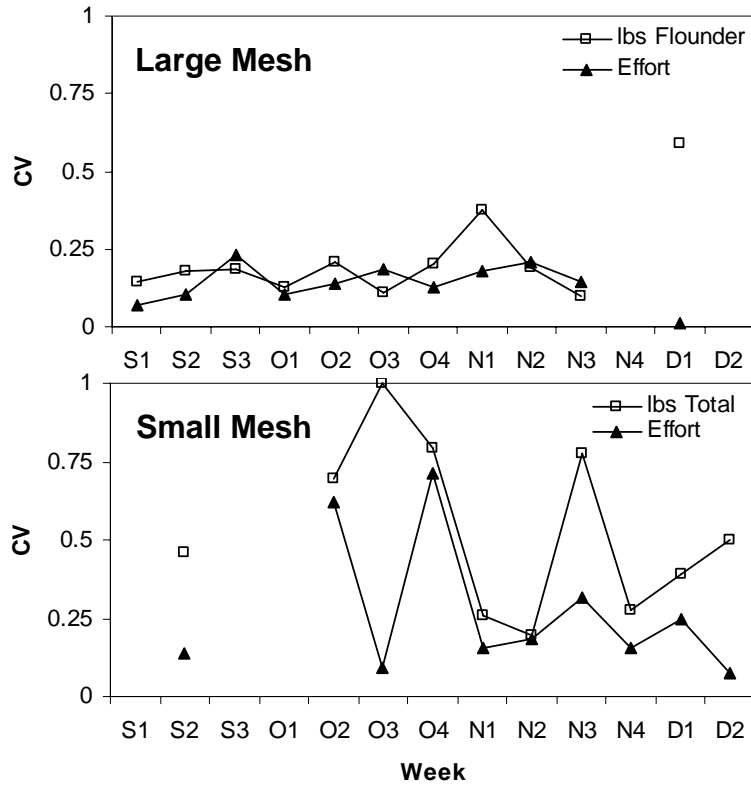


Figure 25. Coefficients of variation (CVs) for observed large mesh fishing effort (lbs of flounder and gillnet yards x soak days) and observed small mesh fishing effort (total lbs and gillnet yards x soak days).

Table 5. Summary statistics for gear parameters observed in the large and small mesh set gillnet fisheries and small mesh runaround gillnet fishery during the 2001 season.

Mesh Size	Net Type	Gear Parameter	N	Min	Mean	Max
Large Mesh	Set Net	Mesh Size (in)	1,486	5.00	6.00	7.50
		Twine Size (mm)	1,486	0.33	0.49	0.57
		Net Depth (ft)	1,486	4.97	9.14	14.42
		Soak Time (hrs)	1,486	12.00	24.26	72.00
		H ₂ O Depth (m)	1,486	0.20	0.79	2.40
		Yards/Trip	131	90	1,002	2,000
Small Mesh	Set Net	Mesh Size (in)	401	3.13	3.81	4.50
		Twine Size (mm)	401	0.40	0.48	0.57
		Net Depth (ft)	401	0.94	6.50	14.06
		Soak Time (hrs)	401	1.00	28.26	72.00
		H ₂ O Depth (m)	401	0.30	1.24	3.70
		Yards/Trip	52	30	757	1,500
Small Mesh	Runaround	Mesh Size (in)	17	3.13	3.76	4.00
		Twine Size (mm)	17	0.40	0.50	0.52
		Net Depth (ft)	17	7.21	10.05	14.42
		Soak Time (hrs)	17	0.17	0.58	2.00
		H ₂ O Depth (m)	17	0.50	0.93	2.00
		Yards/Trip	7	300	833	2,500

from 90 yards/trip up to 2,000 yards/trips with most fishermen averaging around 1000 yards/trip (Table 5). Yardage for the small mesh set net fishery ranged from 30 yards/trip up to 1,500 yards/trip and averaged approximately 750 yards/trip (Table 5). The small mesh runaround gillnet fishery ranged from 300 yards/trip to 2,500 yards/trip and averaged around 800 yards/trip (Table 5). Water depths for the large mesh fishery ranged from 0.2 meters to 2.4 meters and averaged 0.79 meters (Table 5). The small mesh set net fishery ranged slightly deeper to 3.7 meters and averaged 1.24 meters, while the runaround fishery ranged from 0.5 meters to 2 meters and averaged 0.93 meters (Table 5).

Finfish and Sea Bird Bycatch

Catches in the large mesh fishery were dominated by southern flounder, which represented 73.2% of the catch by weight (Table 6). Bluefish, Gulf flounder, sheepshead, and Atlantic menhaden were the next four most common species (Table 6). Red drum were ranked sixth with 137 caught in 130 trips observed (Table 6). Sixty eight percent of the red drum observed in the large mesh fishery were discarded and the mortality rate was 24%. Striped bass were ranked sixteenth by weight with only 6 observed in the large mesh fishery (Table 6). Sea bird bycatch observed in the large mesh fishery included 103 double crested cormorants, 8 common loons, and 1 brown pelican. Sea bird bycatch mortality rates were 65% for cormorants, 38% for loons and the one brown pelican observed was dead.

Striped mullet dominated small mesh set net catches making up 60.7% of the catch by weight (Table 7). Bluefish were second at 12% followed by weakfish, spot, and Atlantic Menhaden (Table 7). Red drum were also ranked sixth by weight in the small mesh set net fishery with 93 observed in 52 trips (Table 7). Eighty eight percent of the red drum observed in the small mesh set net fishery were discarded with an observed mortality rate of 25%. Striped bass were ranked fourteenth by weight with only 3 observed (Table 7). Sea bird bycatch observed in the small mesh set net fishery included 1 double crested cormorant and 1 common loon both of which were dead.

Striped mullet was the most common species observed in small mesh runaround gillnet fishery accounting for 92.5% of the catch (Table 7). Spotted seatrout ranked second at 3.9%, followed by red drum, southern flounder, and spot (Table 7). No other bycatch was observed in the 7 runaround gillnet trips sampled.

Sea Turtle Bycatch

Four green turtles and one hawksbill sea turtles were observed in the large mesh gillnet fishery (Table 8). Two green turtles were observed during the first week of monitoring, one during the second week and one during the fifth week (Table 8). One of the green turtles observed was dead while all others were released alive in good condition (Table 8). Green turtles captured during the first two weeks of the season were small with curved carapace lengths ranging from 300 mm to 360 mm while the one captured during the fifth week was slightly larger at 466 mm (Table 8). Two of the three green turtles released were double tagged with inconel flipper tags. The hawksbill turtle was observed during the first week of the season and had a curved carapace length of 330 mm (Table 8). The hawksbill was in very good condition and was tagged and released alive (Table 8). One of the two greens and the hawksbill observed

Table 6. Tabulation, by species, of relative biomass (weight kgs) and number of individuals observed aboard large mesh flounder gillnet vessels for 130 trips in southeastern Pamlico Sound during the 2001 season. All species are ranked by relative biomass (% weight).

Scientific Name	Common Name	Weight (kgs)	% Weight	Number	% Number
<i>Paralichthys lethostigma</i>	Flounder, Southern	3,019.7	73.2	3,215	49.5
<i>Pomatomus saltatrix</i>	Bluefish	179.5	4.3	383	5.9
<i>Paralichthys albigutta</i>	Flounder, Gulf	166.2	4.0	377	5.8
<i>Archosargus probatocephalus</i>	Sheepshead	149.9	3.6	98	1.5
<i>Brevoortia tyrannus</i>	Menhaden, Atlantic	140.7	3.4	1,006	15.5
<i>Sciaenops ocellatus</i>	Drum, Red	116.0	2.8	137	2.1
<i>Paralichthys dentatus</i>	Flounder, Summer	70.4	1.7	116	1.8
<i>Pogonias cromis</i>	Drum, Black	59.3	1.4	47	0.7
<i>Rhinoptera bonasus</i>	Ray, Cownose	46.1	1.1	79	1.2
<i>Leiostomus xanthurus</i>	Spot	36.0	0.9	181	2.8
<i>Cynoscion regalis</i>	Seatrout, Weakfish	28.8	0.7	79	1.2
<i>Limulus polyphemus</i>	Crab, Horseshoe	12.6	0.3	33	0.5
<i>Morone saxatilis</i>	Bass, Striped	11.8	0.3	6	0.1
<i>Mugil cephalus</i>	Mullet, Striped	10.0	0.2	5	0.1
<i>Lagodon rhomboides</i>	Pinfish	9.4	0.2	138	2.1
<i>Scophthalmus aquosus</i>	Flounder, Windowpane	9.0	0.2	53	0.8
<i>Micropogonias undulatus</i>	Croaker, Atlantic	8.9	0.2	45	0.7
<i>Synodus foetens</i>	Lizardfish, Inshore	8.6	0.2	45	0.7
<i>Cynoscion nebulosus</i>	Seatrout, Spotted	6.2	0.1	10	0.2
<i>Astroscopeus spp.</i>	Stargazers (Astroscopeus)	6.0	0.1	25	0.4
<i>Dasyatis sabina</i>	Stingray, Atlantic	4.9	0.1	60	0.9
<i>Trachinotus carolinus</i>	Pompano, Florida	4.7	0.1	4	0.1
<i>Lobotes surinamensis</i>	Tripletail	3.8	0.1	1	0.0
<i>Callinectes sapidus</i>	Crab, Blue	3.6	0.1	75	1.2
<i>Menticirrhus americanus</i>	Kingfish, Southern	2.3	0.1	10	0.2
<i>Orthopristis chrysoptera</i>	Pigfish	2.1	0.1	22	0.3
<i>Carcharhinus limbatus</i>	Shark, Blacktip	2.1	0.1	1	0.0
<i>Rhizoprionodon terraenovae</i>	Shark, Atlantic Sharpnose	2.0	0.0	1	0.0
<i>Paralichthys spp.</i>	Flounders, Paralichthid	1.6	0.0	4	0.1
<i>Dasyatis americana</i>	Stingray, Southern	1.2	0.0	4	0.1
<i>Dorosoma cepedianum</i>	Shad, Gizzard	0.9	0.0	1	0.0
<i>Chaetodipterus faber</i>	Spadefish, Atlantic	0.9	0.0	3	0.0
<i>Astroscopeus guttatus</i>	Stargazer, Northern	0.9	0.0	2	0.0
<i>Prionotus evolans</i>	Searobin, Striped	0.9	0.0	2	0.0
<i>Sphoeroides maculatus</i>	Puffer, Northern	0.2	0.0	1	0.0
<i>Sphyrna spp.</i>	Barracudas	0.1	0.0	1	0.0
<i>Phalacrocorax Auritus</i>	Cormorant, Double Crested			103	1.6
<i>Raja eglanteria</i>	Skate, Clearnose			34	0.5
<i>Raja spp.</i>	Skates			28	0.4
<i>Dasyatidae</i>	Stingrays			17	0.3
<i>Gavia Immer</i>	Loon, Common			8	0.1
<i>Myliobatis freminvillei</i>	Ray, Bullnose			5	0.1
<i>Libinia spp.</i>	Crabs, Libinia Spider			3	0.0
<i>Rajiformes</i>	Rays			3	0.0
<i>Gymnura micrura</i>	Ray, Smooth Butterfly			3	0.0
<i>Astroscopeus y-graecum</i>	Stargazer, Southern			3	0.0
<i>Chelonia Mydas</i>	Turtle, Green			4	0.1
<i>Majidae</i>	Crabs - Spider			2	0.0
<i>Malaclemys terrapin</i>	Turtle, Diamondback			2	0.0
<i>Menippe mercenaria</i>	Crab, Florida Stone			1	0.0
<i>Dasyatis say</i>	Stingray, Bluntnose			1	0.0
<i>Elops saurus</i>	Ladyfish			1	0.0
<i>Alosa sapidissima</i>	Shad, American			1	0.0
<i>Synodus spp</i>	Lizardfish (Synodus)			1	0.0
<i>Rachycentron canadum</i>	Cobia			1	0.0
<i>Caranx hippos</i>	Jack, Crevalle			1	0.0
<i>Menticirrhus spp.</i>	Kingfishes			1	0.0
<i>Trinectes maculatus</i>	Hogchoker			1	0.0
<i>Eretmochelys imbricata</i>	Turtle, Hawksbill			1	0.0
<i>Pelecanus Occidentalis</i>	Pelican, Brown			1	0.0

Table 7. Tabulation, by species, of relative biomass (weight kgs) and number of individuals observed aboard small mesh set gillnet vessels for 52 trips in southeastern Pamlico Sound during the 2001 season. All species are ranked by relative biomass (% weight).

Scientific Name	Common Name	Weight (kgs)	% Weight	Number	% Number
<i>Mugil cephalus</i>	Mullet, Striped	625.6	60.7	695	41.6
<i>Pomatomus saltatrix</i>	Bluefish	123.5	12.0	198	11.9
<i>Cynoscion regalis</i>	Seatrout, Weakfish	46.8	4.5	75	4.5
<i>Leiostomus xanthurus</i>	Spot	42.3	4.1	135	8.1
<i>Brevoortia tyrannus</i>	Menhaden, Atlantic	37.3	3.6	150	9.0
<i>Sciaenops ocellatus</i>	Drum, Red	36.1	3.5	93	5.6
<i>Cynoscion nebulosus</i>	Seatrout, Spotted	26.2	2.5	28	1.7
<i>Paralichthys lethostigma</i>	Flounder, Southern	18.3	1.8	34	2.0
<i>Pogonias cromis</i>	Drum, Black	17.6	1.7	56	3.4
<i>Paralichthys albigutta</i>	Flounder, Gulf	13.7	1.3	25	1.5
<i>Paralichthys spp.</i>	Flounders, Paralichthid	12.2	1.2	116	7.0
<i>Menticirrhus americanus</i>	Kingfish, Southern	8.5	0.8	13	0.8
<i>Micropogonias undulatus</i>	Croaker, Atlantic	6.3	0.6	13	0.8
<i>Morone saxatilis</i>	Bass, Striped	5.5	0.5	3	0.2
<i>Scomberomorus maculatus</i>	Mackerel, Spanish	5.4	0.5	10	0.6
<i>Lagodon rhomboides</i>	Pinfish	2.2	0.2	6	0.4
<i>Paralichthys dentatus</i>	Flounder, Summer	1.1	0.1	1	0.1
<i>Dasyatis sabina</i>	Stingray, Atlantic	0.6	0.1	1	0.1
<i>Prionotus spp.</i>	Searobins (Prionotus)	0.4	0.0	2	0.1
<i>Synodus foetens</i>	Lizardfish, Inshore	0.3	0.0	2	0.1
<i>Peprilus triacanthus</i>	Butterfish	0.2	0.0	1	0.1
<i>Archosargus probatocephalus</i>	Sheepshead	0.1	0.0	1	0.1
<i>Peprilus alepidotus</i>	Harvestfish	0.1	0.0	1	0.1
<i>Astroscopus guttatus</i>	Stargazer, Northern			2	0.1
<i>Trinectes maculatus</i>	Hogchoker			2	0.1
<i>Callinectes sapidus</i>	Crab, Blue			1	0.1
<i>Trachinotus carolinus</i>	Pompano, Florida			1	0.1
<i>Astroscopus spp.</i>	Stargazers (Astroscopus)			1	0.1
<i>Scophthalmus aquosus</i>	Flounder, Windowpane			1	0.1
<i>Gavia Immer</i>	Loon, Common			1	0.1
<i>Phalacrocorax Auritus</i>	Cormorant, Double Crested			1	0.1

Table 8. Tabulation, by species, of relative biomass (weight kgs) and number of individuals observed aboard small mesh runaround gillnet vessels for 7 trips in southeastern Pamlico Sound during the 2001 season. All species are ranked by relative biomass (% weight).

Scientific Name	Common Name	Weight (kgs)	% Weight	Number	% Number
<i>Mugil cephalus</i>	Mullet, Striped	286.6	92.5	283	88.7
<i>Cynoscion nebulosus</i>	Seatrout, Spotted	12.2	3.9	28	8.8
<i>Sciaenops ocellatus</i>	Drum, Red	9.5	3.1	6	1.9
<i>Paralichthys lethostigma</i>	Flounder, Southern	1.1	0.4	1	0.3
<i>Leiostomus xanthurus</i>	Spot	0.6	0.2	1	0.3

Table 9. Sea turtle takes observed in the large mesh flounder gillnet fishery in Southeastern Pamlico Sound during the 2001 fishing season. Carapace lengths are curved notch to notch measurements.

Date	Species	Condition	Curved	Location	Inconel	Inconel
			Carapace Length (mm)		Tag 1	Tag 2
09/19/2001	Green	Alive	305	35 20.109 75 35.257	XXP551	XXP552
09/20/2001	Green	Dead	300	35 42.635 75 31.463	NA	NA
09/20/2001	Hawksbill	Alive	330	35 42.801 75 31.429	XXP686	XXP687
09/27/2001	Green	Alive	360	35 45.113 75 31.414	NA	NA
10/18/2001	Green	Alive	466	35 14.826 75 38.384	QQS271	QQS274

during the first week of the season were taken in the area just south of Oregon Inlet (Figure 23). During the second week of the season the third green turtle observed in the same area (Figure 23). This prompted NCDMF to close this area to large mesh gillnets and required attendance of small mesh gillnets, establishing the corridor below Oregon Inlet. These regulations remained in effect for the remainder of the season. The other two green turtles observed were taken in S3 in the area behind Cape Hatteras (Figures 23 and 25). No turtle takes were observed in either the small mesh set net fishery or the small mesh runaround gillnet fishery.

Sea Turtle Bycatch Estimates

Sea turtle bycatch was estimated using the stratified ratio method where the bycatch rate was calculated from the number of sea turtles observed per unit of fishing effort. Fishing effort was measured by either gear effort (yards x soak days) or pounds of target species landed. Flounder landings were used for the large mesh gillnet fishery while total landings were used for the multi-species small mesh gillnet fishery. The bycatch rate was then multiplied by the total fishing effort (gear effort or pounds landed) reported by the fishermen for each fishery. The strata were spatially defined by the restricted areas S1, S2, S3, OC, HC. Total bycatch estimates were calculated weekly by adding estimates for each fishery and restricted area. Sea turtle takes were observed during the first, second and fifth weeks and all interactions occurred in the large mesh fishery in S3 (Table 8). Bycatch rates for these weeks were calculated for both observed gear effort and landings by area and species (Table 9). Hawksbill take rates were not calculated because the ITP allowed two observed takes and did not set estimated take thresholds (66 FR 42,845, August 15, 2001). Green turtle bycatch rates based on gear effort were 0.15/1000yds/day for the first week, 0.09/1000yd/day for the second week, and 0.06/1000yds/day for the fifth week (Table 9). Green turtle bycatch rates based on landings were 0.15/100lbs of flounder for the first week, 0.16/100lbs of flounder for the second week, and

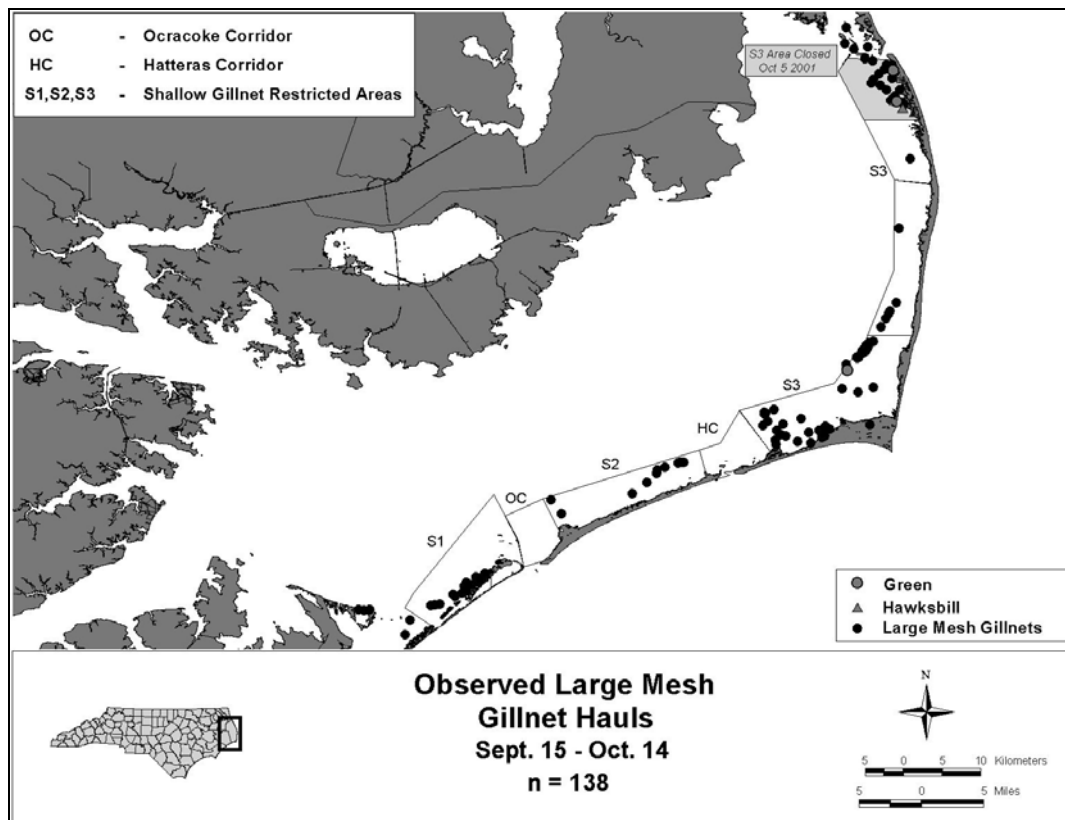


Figure 26. Observed sea turtle interactions and large mesh gillnet sets in southeastern Pamlico Sound gillnet restricted areas from September 15-October 15, 2001.

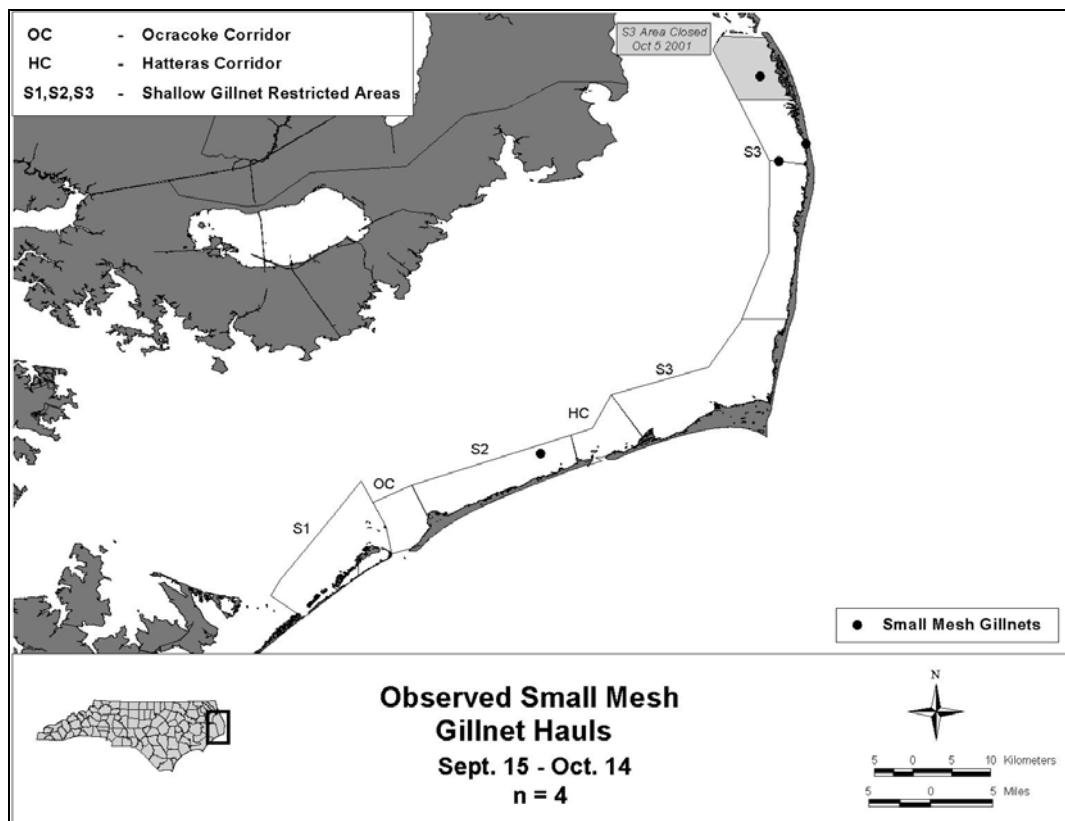


Figure 27. Observed sea turtle interactions and small mesh gillnet sets in southeastern Pamlico Sound gillnet restricted areas from September 15-October 15, 2001.

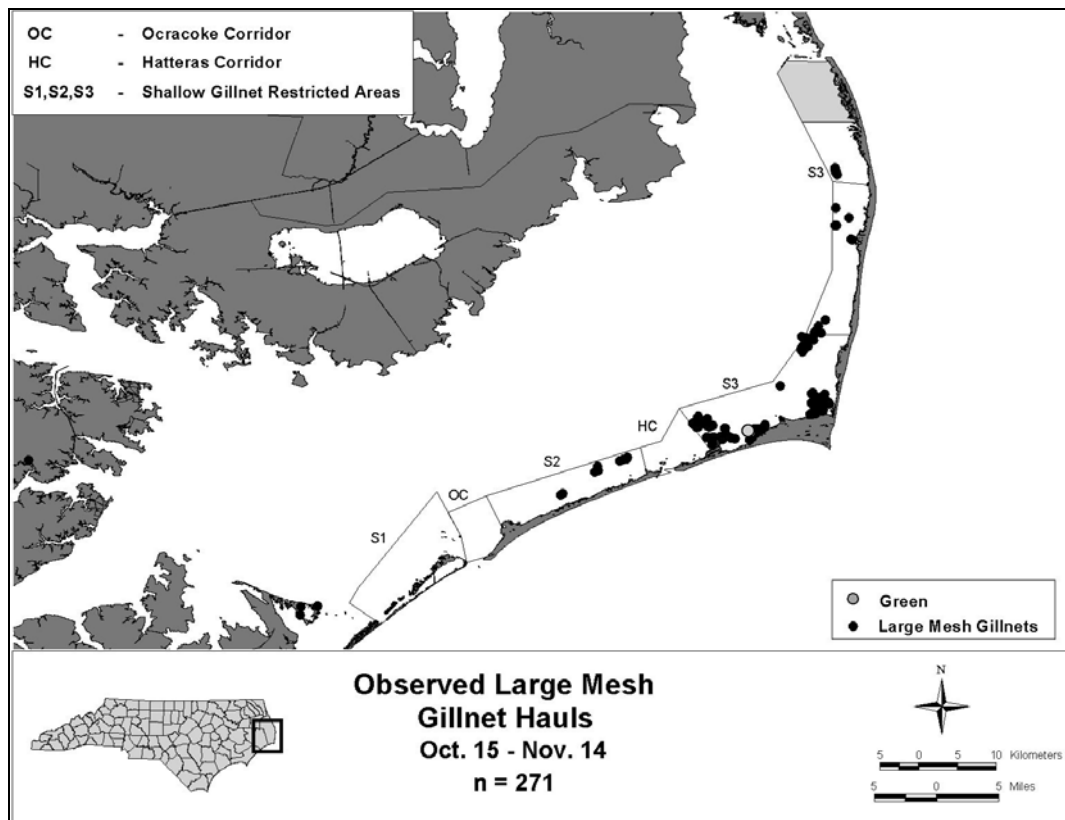


Figure 28. Observed sea turtle interactions and large mesh gillnet sets in southeastern Pamlico Sound gillnet restricted areas from October 16-November 15, 2001.

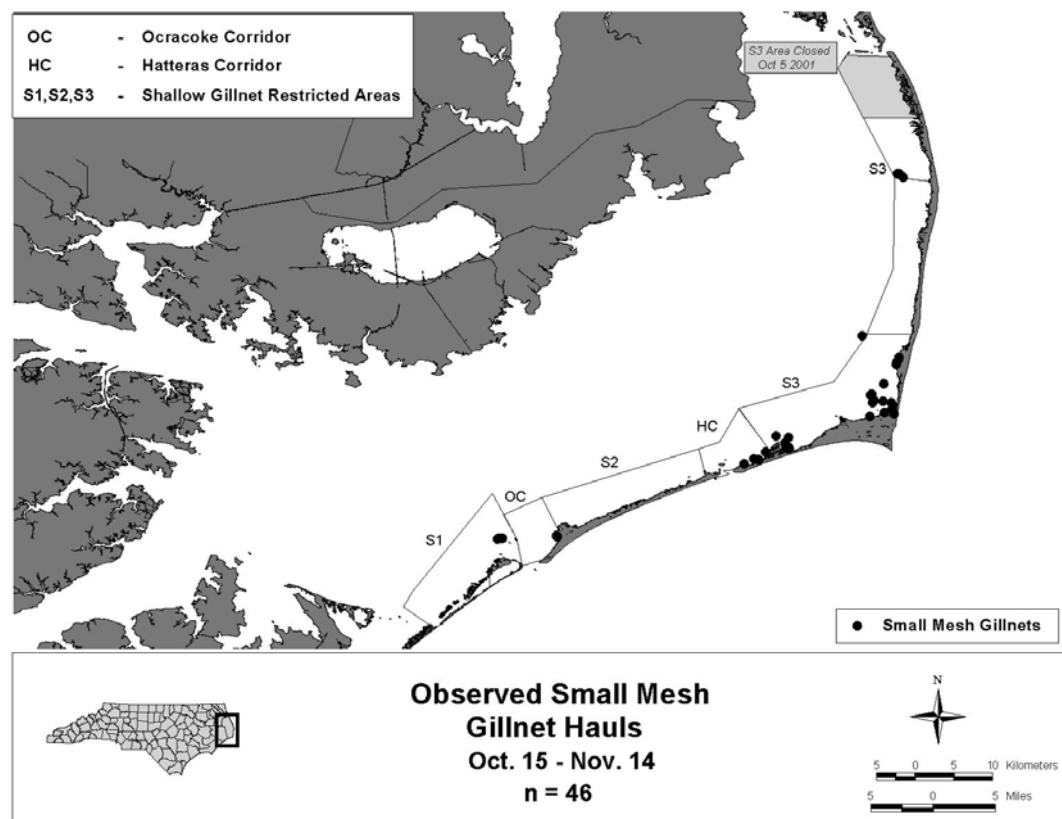


Figure 29. Observed sea turtle interactions and small mesh gillnet sets in southeastern Pamlico Sound gillnet restricted areas from October 16-November 15, 2001.

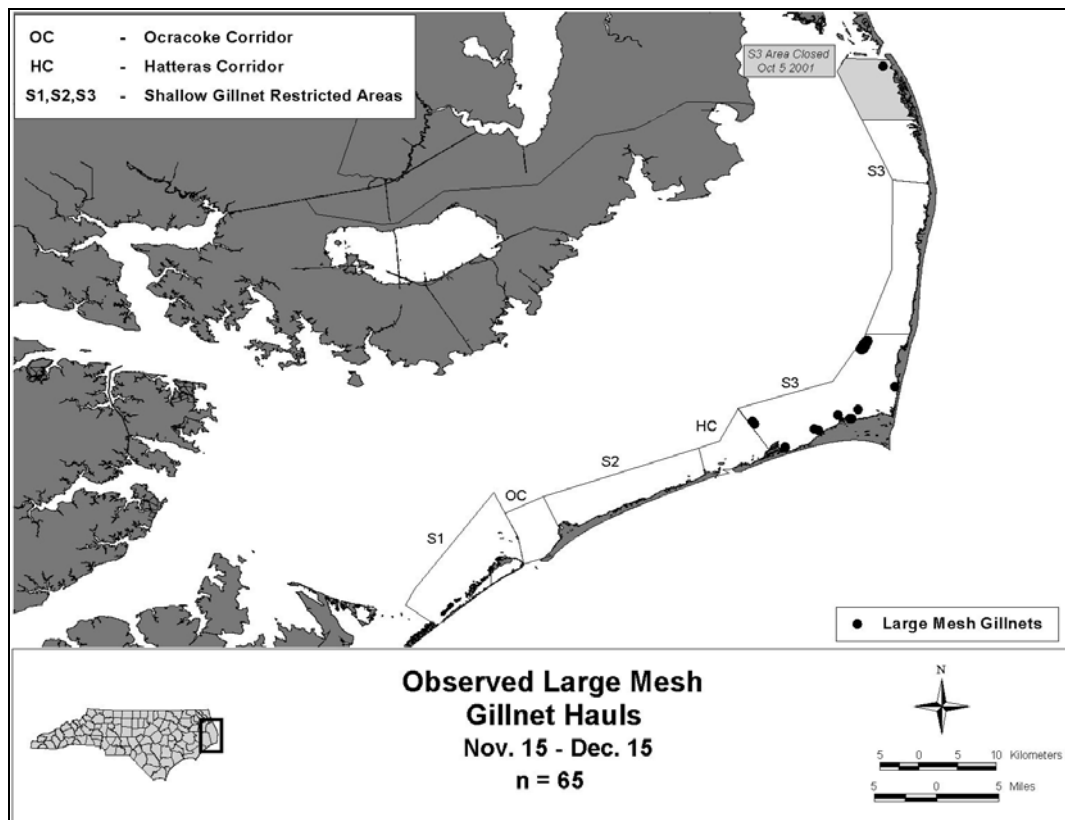


Figure 30. Observed sea turtle interactions and large mesh gillnet sets in southeastern Pamlico Sound gillnet restricted areas from November 16-December 15, 2001.

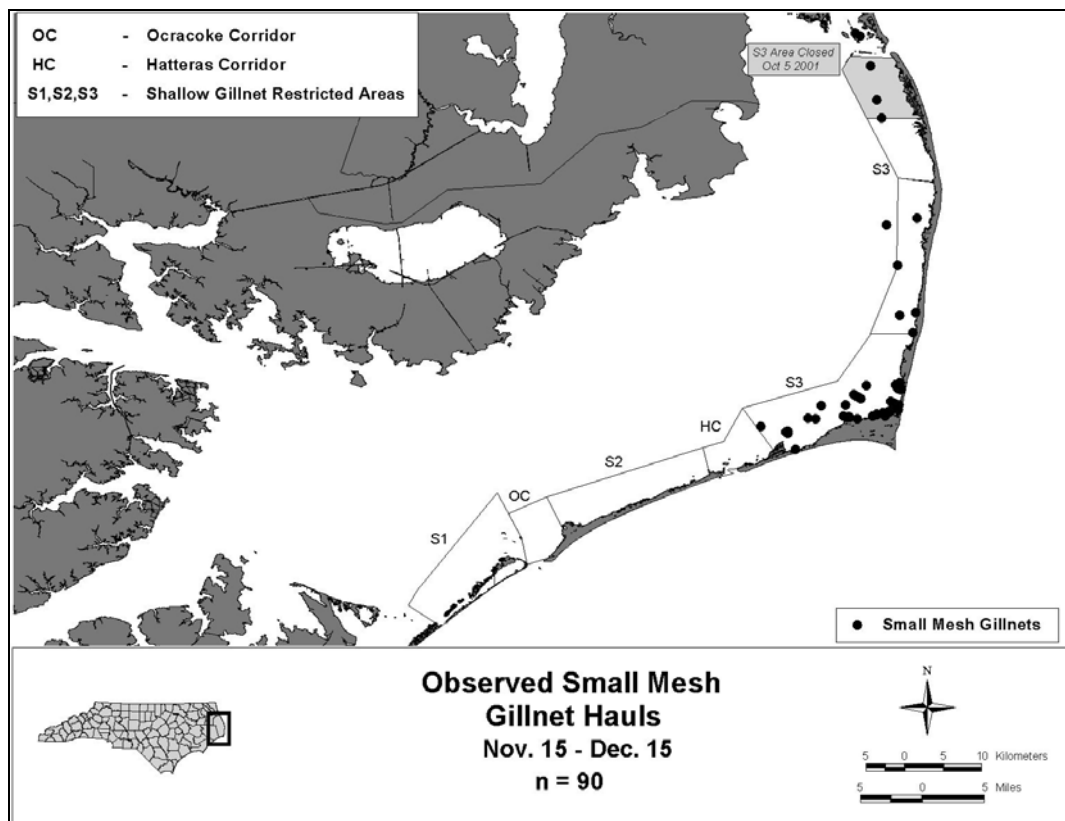


Figure 31. Observed sea turtle interactions and small mesh gillnet sets in southeastern Pamlico Sound gillnet restricted areas from November 16-December 15, 2001.

Table 10. Observed large mesh gillnet green sea turtle interactions, fishing effort (yards x soak days), flounder landings (lbs), and sea turtle bycatch rates based on fishing effort and flounder landings for each week and area where interactions were observed for the 2001 fishing season..

Week	Area	Observed Green Turtles	Observed Effort (Yards x Soak Days)	Observed Flounder (lbs)	Effort Bycatch Rate Turtles/1000yds/day	Landings Bycatch Rate Turtles/100lbs
1	S3	2	14,070	1,342	0.142	0.149
2	S3	1	10,759	611	0.093	0.164
5	S3	1	15,860	1,212	0.063	0.083

Table 11. Reported large mesh gillnet fishing effort (yards x soak days), flounder landings, and green sea turtle bycatch estimates based on gear effort and landings for the 2001 fishing season. Estimates were calculated with bycatch rates listed in Table 10.

Week	Area	Reported Effort (Yards x Soak Days)	Reported Flounder (lbs)	Effort Bycatch Estimate	Landings Bycatch Estimate
1	S3	229,514	21,993	32.625	32.776
2	S3	217,345	9,836	20.201	16.098
5	S3	154,080	9,129	9.715	7.532

Table 12. Estimated and allowed thresholds for lethal and live takes by species from September 15 through December 15, 2001 in the PSGNRA.

Species	Threshold Live Takes	Estimated Live Takes	Threshold Lethal Takes	Estimated Lethal Takes
Kemp's Ridley	164	0	24	0
Green	164	46	24	16
Loggerhead	164	0	24	0
Species Aggregate	492	46	72	16

0.08/100lbs of flounder for the fifth week (Table 9). Bycatch estimates based on gear effort were 32.6 for the first week, 20.2 for the second week, and 9.7 for the fifth week (Table 10). Bycatch estimates based on landings were 32.7 for the first week, 16.1 for the second week, and 7.5 for the fifth week (Table 10). Bycatch estimates were comparable between the two methods with the landings based estimate slightly lower than the gear effort estimate for the second and fifth weeks. Because of the variability associated with landings, NMFS and NCDMF agreed on using gear effort as the measure of fishing effort for bycatch estimates. To determine the lethal and live take estimates the green turtle estimate for the first week was divided between the lethal and live takes observed, which results in an estimate of 16.3 live and 16.3 lethal takes. When the three weekly estimates are added together the total take estimates are 46 live green turtles takes and 16 lethal green turtle takes (Table 11).

Gear Testing

Thirty trips were conducted between October 19 and December 4, 2001. The control net caught 1,419.9 kgs of flounder, while the low profile net caught 1,021.6 kgs, and the double leadline net caught 798.1 kgs (Figure 29 and Tables 13, 14, and 15). Duncan's multiple range test indicated a significant difference between the control and experimental nets but did not detect a significant difference between the experimental nets (Figure 29, Duncan 1955). The

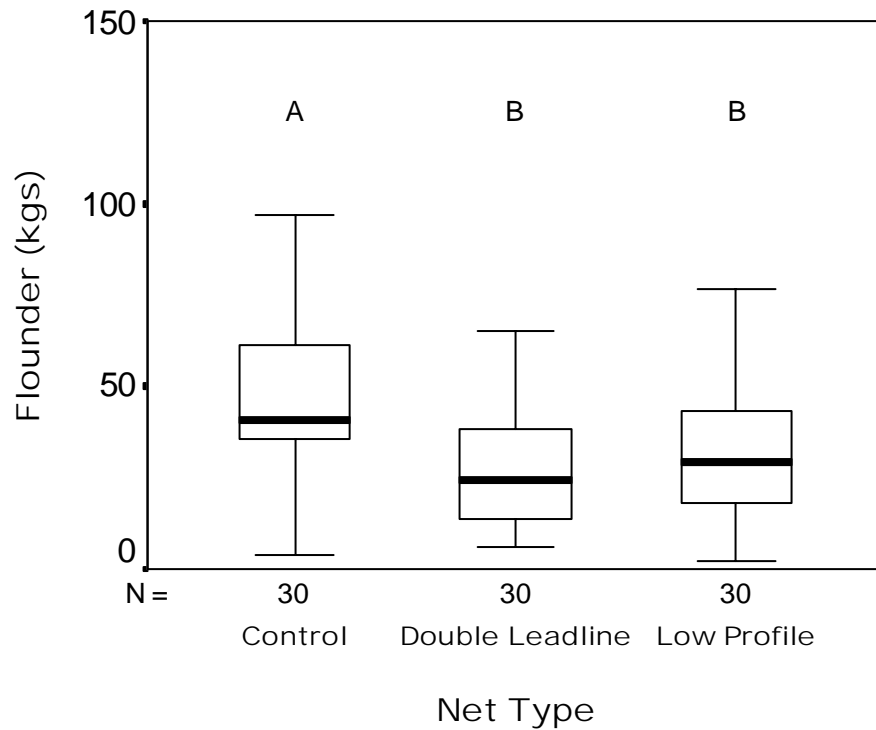


Figure 32. Flounder catch for a standard deep water flounder gillnet with tie-downs (control), a double leadline gillnet and a low profile gillnet without tie-downs. Nets with the same letter are not significantly different from each other ($P < 0.01$).

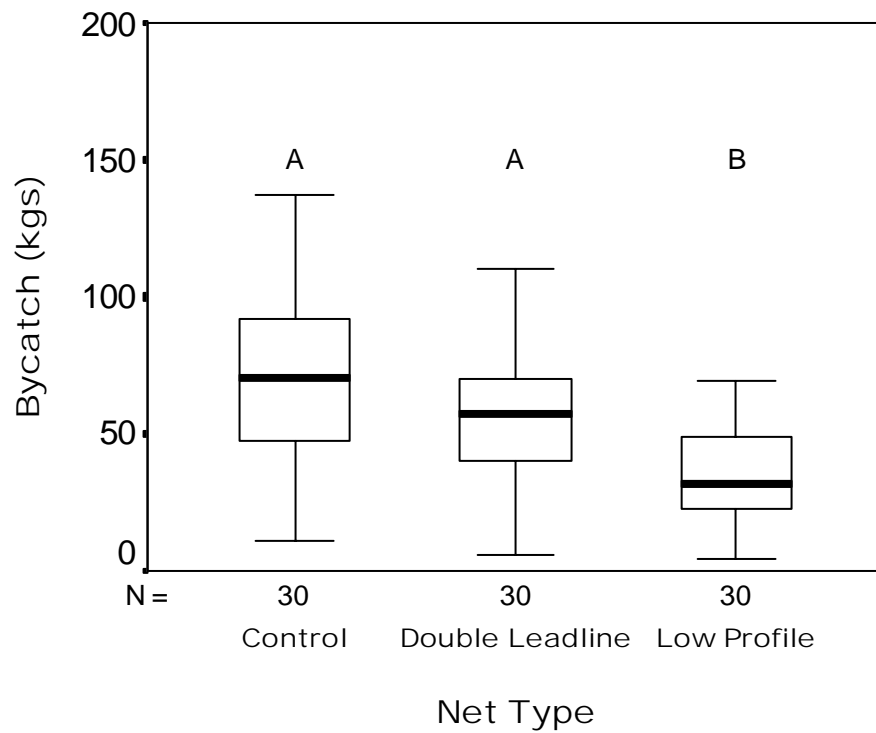


Figure 33. Bycatch for a standard deep water flounder gillnet with tie-downs (control), a double leadline, gillnet and a low profile gillnet without tie-downs. Nets with the same letter are not significantly different from each other ($P < 0.0001$).

Table 13. Tabulation, by species, of relative biomass (weight kgs) and number of individuals collected by a standard flounder gillnet with tie-downs for 30 trips in southeastern Pamlico Sound during the 2001 season. All species are ranked by relative biomass (% weight).

Scientific Name	Common Name	Weight (kgs)	% Weight	Number	% Number
<i>Paralichthys lethostigma</i>	Flounder, Southern	1,419.9	40.6	1,531	28.3
<i>Limulus polyphemus</i>	Crab, Horseshoe	1,049.1	30.0	494	9.1
<i>Brevoortia tyrannus</i>	Menhaden, Atlantic	582.7	16.7	2,372	43.8
<i>Cynoscion regalis</i>	Seatrout, Weakfish	198.1	5.7	608	11.2
<i>Rhinoptera bonasus</i>	Ray, Cownose	73.6	2.1	47	0.9
<i>Raja eglanteria</i>	Skate, Clearnose	25.6	0.7	18	0.3
<i>Pomatomus saltatrix</i>	Bluefish	23.8	0.7	58	1.1
<i>Dasyatidae</i>	Stingrays	19.9	0.6	27	0.5
<i>Menticirrhus americanus</i>	Kingfish, Southern	15.9	0.5	49	0.9
<i>Dasyatis americana</i>	Stingray, Southern	8.8	0.3	9	0.2
<i>Rhizoprionodon terraenovae</i>	Shark, Atlantic Sharpnose	8.4	0.2	3	0.1
<i>Synodus foetens</i>	Lizardfish, Inshore	7.4	0.2	23	0.4
<i>Acipenser oxyrinchus</i>	Sturgeon, Atlantic	7.0	0.2	1	0.0
<i>Astroscopus spp.</i>	Stargazers (Astroscopus)	6.5	0.2	7	0.1
<i>Phalacrocorax Auritus</i>	Cormorant, Double Crested	6.4	0.2	8	0.1
<i>Paralichthys dentatus</i>	Flounder, Summer	6.3	0.2	12	0.2
<i>Myliobatis freminvillei</i>	Ray, Bullnose	4.6	0.1	4	0.1
<i>Leiostomus xanthurus</i>	Spot	4.2	0.1	23	0.4
<i>Paralichthys albigutta</i>	Flounder, Gulf	4.0	0.1	7	0.1
<i>Micropogonias undulatus</i>	Croaker, Atlantic	3.4	0.1	33	0.6
<i>Busycon spp.</i>	Whelks	3.2	0.1	12	0.2
<i>Squalus acanthias</i>	Dogfish, Spiny	2.2	0.1	1	0.0
<i>Archosargus probatocephalus</i>	Sheepshead	2.1	0.1	1	0.0
<i>Gymnura spp.</i>	Rays, Butterfly	1.7	0.0	9	0.2
<i>Astroscopus y-graecum</i>	Stargazer, Southern	1.6	0.0	5	0.1
<i>Prionotus carolinus</i>	Searobin, Northern	1.5	0.0	7	0.1
<i>Orthopristis chrysoptera</i>	Pigfish	1.3	0.0	7	0.1
<i>Scophthalmus aquosus</i>	Flounder, Windowpane	1.3	0.0	4	0.1
<i>Menticirrhus saxatilis</i>	Kingfish, Northern	1.0	0.0	3	0.1
<i>Pogonias cromis</i>	Drum, Black	1.0	0.0	1	0.0
<i>Peprilus alepidotus</i>	Harvestfish	0.8	0.0	4	0.1
<i>Bairdiella chrysoura</i>	Perch, Silver	0.6	0.0	4	0.1
<i>Cnidaria</i>	Jellyfish	0.5	0.0	1	0.0
<i>Callinectes sapidus</i>	Crab, Blue	0.5	0.0	3	0.1
<i>Prionotus evolans</i>	Searobin, Striped	0.4	0.0	2	0.0
<i>Astroscopus guttatus</i>	Stargazer, Northern	0.4	0.0	1	0.0
<i>Peprilus triacanthus</i>	Butterfish	0.4		2	0.0
<i>Busycon carica</i>	Whelk, Knobbed	0.3		2	0.0
<i>Lagodon rhomboides</i>	Pinfish	0.3		2	0.0
<i>Menticirrhus littoralis</i>	Kingfish, Gulf	0.3		1	0.0
<i>Cynoscion nebulosus</i>	Seatrout, Spotted	0.2		1	0.0
<i>Sphoeroides maculatus</i>	Puffer, Northern	0.2		1	0.0
<i>Busycotypus canaliculatus</i>	Whelk, Channeled	0.1		1	0.0
<i>Callinectes similis</i>	Crab, Lesser Blue	0.0		3	0.1
<i>Lepidochelys kempii</i>	Turtle, Kemp's Ridley			3	0.1

Table 14. Tabulation, by species, of relative biomass (weight kgs) and number of individuals collected by a modified low profile flounder gillnet without tie-downs for 30 trips in southeastern Pamlico Sound during the 2001 season. All species are ranked by relative biomass (% weight).

Scientific Name	Common Name	Weight (kgs)	% Weight	Number	% Number
<i>Paralichthys lethostigma</i>	Flounder, Southern	1,021.6	49.4	1,098	35.2
<i>Limulus polyphemus</i>	Crab, Horseshoe	508.2	24.6	231	7.4
<i>Brevoortia tyrannus</i>	Menhaden, Atlantic	312.3	15.1	1,291	41.4
<i>Cynoscion regalis</i>	Seatrout, Weakfish	87.2	4.2	265	8.5
<i>Rhinoptera bonasus</i>	Ray, Cownose	30.8	1.5	20	0.6
<i>Dasyatidae</i>	Stingrays	18.2	0.9	25	0.8
<i>Menticirrhus americanus</i>	Kingfish, Southern	14.6	0.7	41	1.3
<i>Pomatomus saltatrix</i>	Bluefish	12.0	0.6	28	0.9
<i>Morone saxatilis</i>	Bass, Striped	10.4	0.5	1	0.0
<i>Dasyatis americana</i>	Stingray, Southern	7.6	0.4	6	0.2
<i>Raja eglanteria</i>	Skate, Clearnose	4.7	0.2	4	0.1
<i>Paralichthys dentatus</i>	Flounder, Summer	4.5	0.2	10	0.3
<i>Archosargus probatocephalus</i>	Sheepshead	4.0	0.2	2	0.1
<i>Synodus foetens</i>	Lizardfish, Inshore	3.9	0.2	12	0.4
<i>Leiostomus xanthurus</i>	Spot	2.8	0.1	9	0.3
<i>Squalus acanthias</i>	Dogfish, Spiny	2.8	0.1	1	0.0
<i>Astroscopus spp.</i>	Stargazers (Astroscopus)	2.6	0.1	3	0.1
<i>Pogonias cromis</i>	Drum, Black	2.5	0.1	2	0.1
<i>Busycon spp.</i>	Whelks	2.4	0.1	12	0.4
<i>Micropogonias undulatus</i>	Croaker, Atlantic	2.3	0.1	21	0.7
<i>Menticirrhus spp.</i>	Kingfishes	1.4	0.1	3	0.1
<i>Paralichthys albigutta</i>	Flounder, Gulf	1.3	0.1	2	0.1
<i>Rhizoprionodon terraenovae</i>	Shark, Atlantic Sharpnose	1.2	0.1	1	0.0
<i>Cnidaria</i>	Jellyfish	1.0	0.0	2	0.1
<i>Orthopristis chrysoptera</i>	Pigfish	0.8	0.0	4	0.1
<i>Astroscopus guttatus</i>	Stargazer, Northern	0.8	0.0	2	0.1
<i>Scophthalmus aquosus</i>	Flounder, Windowpane	0.8	0.0	3	0.1
<i>Astroscopus y-graecum</i>	Stargazer, Southern	0.7	0.0	1	0.0
<i>Menticirrhus littoralis</i>	Kingfish, Gulf	0.6	0.0	2	0.1
<i>Tautoga onitis</i>	Tautog	0.6	0.0	1	0.0
<i>Prionotus carolinus</i>	Searobin, Northern	0.5	0.0	2	0.1
<i>Busycon carica</i>	Whelk, Knobbed	0.4	0.0	2	0.1
<i>Gymnura spp.</i>	Rays, Butterfly	0.2	0.0	2	0.1
<i>Gymnura micrura</i>	Ray, Smooth Butterfly	0.2	0.0	1	0.0
<i>Myliobatis freminvillei</i>	Ray, Bullnose	0.2	0.0	1	0.0
<i>Prionotus tribulus</i>	Searobin, Bighead	0.2	0.0	1	0.0
<i>Peprilus triacanthus</i>	Butterfish	0.2		1	0.0
<i>Ancylosetta quadrocellata</i>	Flounder, Ocellated	0.2		1	0.0
<i>Busycotypus canaliculatus</i>	Whelk, Channeled	0.1		1	0.0
<i>Peprilus alepidotus</i>	Harvestfish	0.1		1	0.0

Table 15. Tabulation, by species, of relative biomass (weight kgs) and number of individuals collected by a modified double leadline flounder gillnet for 30 trips in southeastern Pamlico Sound during the 2001 season. All species are ranked by relative biomass (% weight).

Scientific Name	Common Name	Weight (kgs)	% Weight	Number	% Number
<i>Paralichthys lethostigma</i>	Flounder, Southern	798.1	31.9	889	17.8
<i>Brevoortia tyrannus</i>	Menhaden, Atlantic	704.7	28.2	2,749	55.1
<i>Limulus polyphemus</i>	Crab, Horseshoe	565.9	22.6	332	6.7
<i>Cynoscion regalis</i>	Seatrout, Weakfish	173.5	6.9	498	10.0
<i>Pomatomus saltatrix</i>	Bluefish	56.8	2.3	131	2.6
<i>Raja eglanteria</i>	Skate, Clearnose	29.2	1.2	21	0.4
<i>Menticirrhus americanus</i>	Kingfish, Southern	25.0	1.0	80	1.6
<i>Rhinoptera bonasus</i>	Ray, Cownose	24.6	1.0	17	0.3
<i>Dasyatidae</i>	Stingrays	20.8	0.8	23	0.5
<i>Synodus foetens</i>	Lizardfish, Inshore	12.8	0.5	41	0.8
<i>Phalacrocorax Auritus</i>	Cormorant, Double Crested	11.2	0.4	10	0.2
<i>Rhizoprionodon terraenovae</i>	Shark, Atlantic Sharpnose	8.5	0.3	3	0.1
<i>Astroscopus spp.</i>	Stargazers (Astroscopus)	7.4	0.3	7	0.1
<i>Paralichthys dentatus</i>	Flounder, Summer	7.2	0.3	14	0.3
<i>Acipenser oxyrinchus</i>	Sturgeon, Atlantic	6.0	0.2	1	0.0
<i>Dasyatis americana</i>	Stingray, Southern	5.5	0.2	6	0.1
<i>Paralichthys albigutta</i>	Flounder, Gulf	4.3	0.2	9	0.2
<i>Astroscopus guttatus</i>	Stargazer, Northern	4.0	0.2	7	0.1
<i>Myliobatis freminvillei</i>	Ray, Bullnose	3.9	0.2	4	0.1
<i>Leiostomus xanthurus</i>	Spot	3.8	0.2	17	0.3
<i>Micropogonias undulatus</i>	Croaker, Atlantic	3.7	0.1	35	0.7
<i>Busycon spp.</i>	Whelks	3.7	0.1	20	0.4
<i>Orthopristis chrysoptera</i>	Pigfish	2.8	0.1	14	0.3
<i>Squalus acanthias</i>	Dogfish, Spiny	2.3	0.1	1	0.0
<i>Archosargus probatocephalus</i>	Sheepshead	2.2	0.1	1	0.0
<i>Busycon carica</i>	Whelk, Knobbed	2.1	0.1	13	0.3
<i>Lagodon rhomboides</i>	Pinfish	1.8	0.1	10	0.2
<i>Astroscopus y-graecum</i>	Stargazer, Southern	1.2	0.0	3	0.1
<i>Pogonias cromis</i>	Drum, Black	0.8	0.0	2	0.0
<i>Busycotypus canaliculatus</i>	Whelk, Channeled	0.6	0.0	6	0.1
<i>Menticirrhus spp.</i>	Kingfishes	0.6	0.0	2	0.0
<i>Menticirrhus littoralis</i>	Kingfish, Gulf	0.6	0.0	2	0.0
<i>Cnidaria</i>	Jellyfish	0.5	0.0	1	0.0
<i>Gymnura spp.</i>	Rays, Butterfly	0.5	0.0	2	0.0
<i>Prionotus carolinus</i>	Searobin, Northern	0.4	0.0	2	0.0
<i>Tautoga onitis</i>	Tautog	0.4	0.0	1	0.0
<i>Prionotus evolans</i>	Searobin, Striped	0.3		2	0.0
<i>Scophthalmus aquosus</i>	Flounder, Windowpane	0.3		1	0.0
<i>Prionotus tribulus</i>	Searobin, Bighead	0.2		1	0.0
<i>Cynoscion nebulosus</i>	Seatrout, Spotted	0.2		1	0.0
<i>Bairdiella chrysoura</i>	Perch, Silver	0.2		2	0.0
<i>Triglidae</i>	Searobins	0.1		1	0.0
<i>Peprilus triacanthus</i>	Butterfish	0.1		1	0.0
<i>Peprilus alepidotus</i>	Harvestfish	0.1		1	0.0
<i>Lepidochelys kempii</i>	Turtle, Kemp's Ridley			1	0.0

control net caught 2,078.5 kgs of bycatch, while the double leadline net caught 1,695.5 kgs, and the low profile caught 1,044.2 kgs (Figure 30 and Tables 13, 14, and 15). Duncan's multiple range test indicated a difference between the experimental nets but did not detect a significant difference between the control net and the double leadline net (Figure 30, Duncan 1955). The bycatch reductions were primarily reductions of marketable species including horseshoe crabs and weakfish (Figure 31 and Tables 13, 14, and 15). Although bycatch was collectively reduced for marketable, unmarketable, and regulatory categories by both experimental nets, the double leadline net caught more Atlantic menhaden and bluefish than the control net (Tables 13 and 15).

Twelve live and five lethal sea turtle interactions were allowed under the 2001 ITP (66 FR 42,845, August 15, 2001). These take levels were collective for the three most common species green, Kemp's ridley, and loggerhead. Four Kemp's Ridley turtles were caught during the study and all were captured dead (Table 16). Three were caught in the control net and one was captured in the double leadline net (Table 16). All four were caught in the same area located just outside the PSGNRA behind Hatteras Inlet (Figure 32).

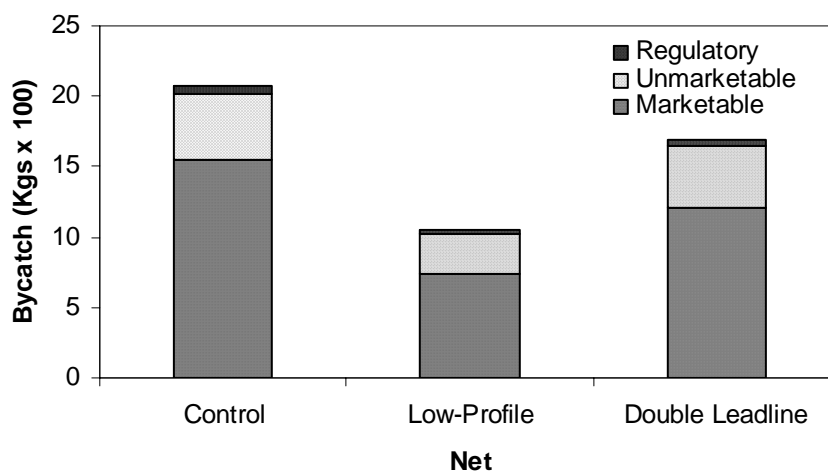


Figure 34. Bycatch components for a standard deep water flounder gillnet with tie-downs (control), a double leadline gillnet and a low profile gillnet without tie-downs.

Table 16. Sea turtle interactions observed by net type during 2001 gear testing in southeastern Pamlico Sound.

Date	Net Type	Species	Carapace Length (mm)	Condition
10/21/2001	Control	Kemp's Ridley	370	Dead
10/22/2001	Control	Kemp's Ridley	380	Dead
11/07/2001	Double Leadline	Kemp's Ridley	375	Dead
11/07/2001	Control	Kemp's Ridley	355	Dead

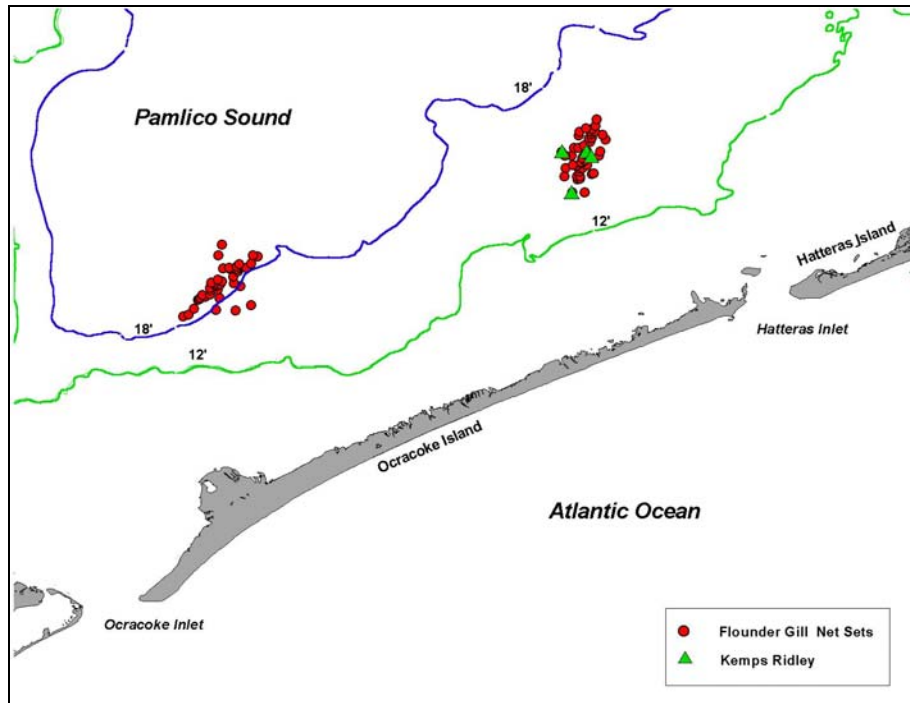


Figure 35. Locations of experimental flounder gillnet sets and sea turtle interactions in southeastern Pamlico Sound during 2001 gear testing.

DISCUSSION

The gillnet management measures imposed by NCDMF and NMFS in Pamlico Sound during the 2001 fishing season were successful in reducing sea turtle bycatch, while allowing fisheries to operate. Observed takes of sea turtles were down significantly from takes in 2000. There were an estimated 122 live takes and 84 lethal takes in 2000, while 2001 take levels are estimated to be 46 live and 16 lethal. The 70% reduction came at the expense of the deep water flounder gillnet fishery, which was responsible for approximately 78% of the 2000 takes (Gearhart 2001). Take levels observed in the shallow water large mesh gillnet fishery during 2001, which covered twice the area of the 2000 PSGNRA, were similar to those observed during the 2000 fishing season (Figures 1, 4 and Table 12). Three live and one lethal take observed in the shallow water large mesh fishery during 2000 provided estimates of 54 live and 15 lethal sea turtle takes (Gearhart 2001). This reduction in interactions can be attributed to NCDMF regulations, which set yardage limits and prohibited large mesh gillnets near inlets. Three of the four shallow water interactions in 2000 occurred in close proximity to Hatteras and Ocracoke Inlets (Gearhart 2001). Three of the five takes observed during 2001 were in close proximity to Oregon Inlet, which was later closed to large mesh gillnets (Figure 23). Only one other take was observed after that closure (Figure 25).

No sea turtle interactions were observed in the small mesh gillnet fisheries. Attendance requirements in the PSGNRA reduced set net fishing effort prior to November 1. Before November 1, the primary small mesh fishing mode was runaround gillnet. Fishing practices

associated with this technique, short (1 hr) soak times and shallow depth of water fished (< 3 ft), minimized the bycatch of finfish and sea turtles (Tables 5 and 8).

Four of the five sea turtles observed in the shallow water large mesh fishery during the 2001 season were released alive (Table 9). During the 2000 season, three of the four sea turtles observed in the shallow water large mesh gillnet fishery were released alive (Gearhart 2001). The high survival rate during both years can be credited to the fishing practices of the fleet, which includes fishing their nets daily and setting in shallow (< 3 ft) areas of the sound (Table 5). The shallow water depths provide incidentally captured sea turtles with the ability to reach the surface while entangled and the shorter soak times reduces the amount of time captured turtles must remain in the net.

During the 2000 season, all of the turtles observed in the shallow water large mesh gillnet fishery were green sea turtles, while takes in the deep water fishery were composed of primarily Kemp's Ridley and Loggerheads (Gearhart 2001). Four green and one hawksbill were observed in the 2001 shallow water large mesh gillnet fishery and the four turtles observed during the 2001 deep water gear testing were all Kemp's Ridley (Tables 9 and 16). Additionally, the four green turtles observed in the shallow water fishery during the 2000 season were captured before October 6, while four of the five 2001 shallow water takes occurred before October 1 (Table 9). Given this temporal trend in species diversity, it appears that the first few weeks of the shallow water flounder gillnet season presents the highest potential for green sea turtle interactions. According to 2001 PSGNRA permit reports this is also the part of the season with largest amount of flounder gillnet effort and landings (Figures 6 – 10). Notably, the week with the highest number of trips during 2001 was the first week of the season. This means that there were probably large mesh gillnet trips occurring several weeks prior to 2001 ITP start date of September 15. It is clear that the first few weeks of the season are the most critical and areas near the inlets should be avoided during this time. If large mesh gillnet effort is significant prior to September 15, especially near the inlets, then interactions are likely occurring. Restrictions which establish the inlet corridors and prohibit large mesh gillnets near the inlets should be imposed several weeks prior to September to further reduce interactions.

The 2001 deep water experimental gillnet study provided some useful insights. Although, the study was designed to evaluate the effectiveness of two modified gillnets in catching flounder. This portion of the study meet with limited success with both nets catching significantly fewer flounder than a traditional flounder gillnet (Figure 29). Additionally, the low profile net caught significantly less bycatch than the control net but the bycatch that was reduced was primarily marketable bycatch (Figures 30 and 31). These results suggest less income per trip if fishermen were required to use the low profile net. The double leadline net also caught significantly fewer flounder but maintained a portion of the marketable bycatch (Figures 29 and 31). In addition, three sea turtle interactions were observed in the control net while none were observed in the low profile net and one was observed in the double leadline net (Table 16). These results indicate that further testing and refinement of the gear are warranted.

CONCLUSIONS AND RECOMMENDATIONS

Successful management of the Pamlico Sound gillnet fisheries in 2001 indicates that the management measures imposed will be sufficient for future use to reduce sea turtle strandings in the region. Further reductions can also be realized by increasing the time frame of the management measures to include the first few weeks of September and possibly the last few weeks of August. Additionally, further reductions of potential sea turtle strandings could be achieved by expanding the Oregon Inlet corridor to include both the North and South sides of the inlet. The establishment of the inlet corridors was a key component of the 2001 management plan and should be utilized in future plans to manage this and other areas throughout the state.

The NCDMF 2001 monitoring program was comprehensive but it was also costly and labor intensive. A cooperative effort including Marine Patrol, Fisheries Management, Information Technology, and License and Statistics was needed to successfully administer the program. Nearly all the NCDMF employees that worked on the 2001 monitoring project suspended their existing duties to complete tasks required. Since a successful management strategy has been identified through NCDMF data collections, future management plans for this area should be long term (5-years) and should seek to eliminate intensive monitoring. The large area covered by the management measures and the number of participants and subsequent trips in these fisheries requires a large number of observer trips. A more efficient monitoring strategy could utilize stranding network monitoring to identify “hot spots” which would trigger intensive observer monitoring in the vicinity of the stranding event. This would provide a means of identifying causes related to future stranding events in the area and allow for more efficient use of existing NCDMF staff. This type of monitoring program would be cost effective reducing the amount of NMFS funding required to establish a long term observer program in this area.

The 2001 deep water experimental gillnet study indicates that further testing and refinement of the gears are warranted. The development of a gillnet design that eliminates sea turtle bycatch, while maintaining at least a significant portion of the marketable catch would provide a viable option for fishermen that have experienced the severe economic impacts of the Pamlico Sound deep water gillnet closure, while averting user conflicts in adjacent fisheries.

LITERATURE CITED

- Duncan, D.B. 1955. Multiple range and multiple F tests. *Biometrics*. 11:1-42.
- Gearhart J. 2001. Sea turtle bycatch monitoring of the 2000 fall flounder gillnet fishery of southeastern Pamlico Sound, North Carolina. Completion Report for ITP 1259. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. 26pp.
- NCMFC. 2001. North Carolina fisheries rules for coastal waters. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC, USA. 277pp.
- NMFS. 1996. Fisheries Sampling Branch-Observer Manual. Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543-1026. 33pp.